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P578

PHYSICS ABSTRACTS

SECTION A

of

SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

Edited and Issued Monthly by

THE INSTITUTION OF ELECTRICAL ENGINEERS

In Association with

THE PHYSICAL SOCIETY

THE INSTITUTE OF PHYSICS

THE AMERICAN PHYSICAL SOCIETY

THE AMERICAN
INSTITUTE OF ELECTRICAL ENGINEERS

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ABSTRACTS 9349–10160

VOLUME 58 **DECEMBER 1955** NUMBER 696

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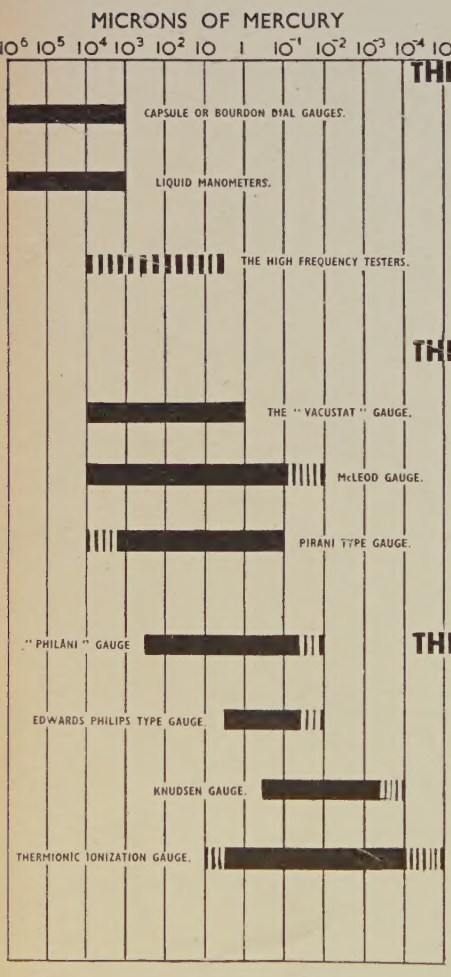

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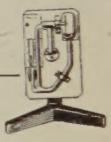

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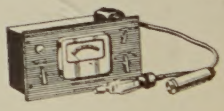

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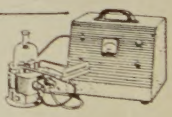

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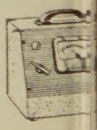

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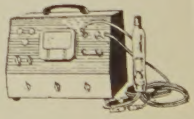

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RELATED SUBJECTS CONTAINED IN SECTION B (ELECTRICAL ENGINEERING ABSTRACTS)

Electrical and magnetic measurements and instruments
Electronic relays and counters
Automatic control mechanisms
Applied electrochemistry
Lines and networks
Waveguides
Photocells
Thermionic tubes
Cathode-ray tubes
X-ray tubes
Oscillators. Pulse circuits
Amplifiers
Electroacoustic apparatus
Radiocommunication
Mechanical engineering
Illumination

LIST OF JOURNALS

The following list supplements the Lists of Journals published with the January number of Volume 56 (1953) and the Supplements published with the Indexes to Volumes 56 (1953) and 57 (1954). Reprints of the List of Journals (1953) and the Supplements (1953 and 1954) can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s. 0d. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Bull. Naniwa Univ. A.	*Bulletin of Naniwa University. Series A: Engineering and Natural Sciences.* Naniwa University, Sakai, Osaka.
Electrotehnica	*Electrotehnica.* Str. Ion Ghica Nr. 3, Bucharest.
Energetica Hidrotehnica	*Energetica si Hidrotehnica.* Str. Ion Ghica Nr. 3, Bucharest.
"J. Stefan" Inst. Rep.	*"J. Stefan" Institute Reports.* "J. Stefan" Institute of Physics, Ljubljana, P.O.B. 199, Yugoslavia.
Japan J. Geophys.	*Japanese Journal of Geophysics.* Science Council of Japan, Ueno Park, Tokyo.
Wiss. Z. Hochsch. Elektrotech. Ilmenau	*Wissenschaftliche Zeitschrift der Hochschule für Elektrotechnik Ilmenau.* Ilmenau in Thuringen, Germany.

Errata

Abstr. 3957 (1955) line 5: *for* Pt I *read* Pt II.

Abstr. 4832 (1955) lines 2 and 3: *for* J. JANSEN and L. M. DAWSON *read* L. JANSEN and J. M. DAWSON.

Abstr. 5907–8, 5918, 5982, 6081, 6094, 6138, 6180, 6295, 6440, 6519, 6544 (1955), journal reference: *for* Vol. **16** *read* Vol. **10.**

Abstr. 6072 (1955) line 2: *for* KROLAC *read* KROLAK.

Abstr. 6484 (1955) line 1: *for* **Report on** *read* **Report of.**

Abstr. 7084 (1955) line 1: *for* **h.v.** *read* **h.f.**

Abstr. 8410 (1955): *for* CHANDRASEKARAN *read* CHANDRASEKHARAN.

Abstr. 8458 (1955) line 8: *insert* H. L. ANDERSON and S. K. ALLISON *as authors.*

Abstr. 9012 (1955) line 8: *for* 1150 *read* 11150.

Author index (1954) p. 1651, column 2: insert 10783 after 6274 in entry under Takahashi, Y. and delete entry under Takagashi, Y.

Corrections to Articles

Corrections have been published, as shown below, to the articles whose abstract numbers are given. Unless otherwise stated, the volume and page given refer to the journal named in the abstract, i.e. the journal in which the original article was published.

Abstr. 6839 (1954): **13,** *No.* 2, 224 (*Feb.*, 1955).
Abstr. 1616 (1955): **26,** No. 9, 888 (*Sept.*, 1955).
Abstr. 1618 (1955): **26,** No. 9, 1187 (*Sept.*, 1955).
Abstr. 4861 (1955): **13,** *No.* 2, 225 (*Feb.*, 1955).
Abstr. 4872 (1955): **13,** *No.* 1, 127 (*Jan.*, 1955).
Abstr. 4906–7 (1955): **13,** *No.* 1, 127 (*Jan.*, 1955).
Abstr. 6186 (1955): **141,** *No.* 5, 659 (1955).
Abstr. 6461 (1955): **13,** *No.* 2, 225 (*Feb.*, 1955).
Abstr. 6544 (1955): **10,** *No.* 8, 727 (*Aug.*, 1955).
Abstr. 7662 (1955): **122,** *No.* 2, 361 (*Sept.*, 1955).
Abstr. 7818 (1955): **241,** *No.* 6, 584 (*Aug.* 8, 1955).
Abstr. 8129 (1955): **10,** *No.* 9, 828 (*Sept.*, 1955).
Abstr. 8406 (1955): **26,** *No.* 9, 888 (*Sept.*, 1955).

517

9349. On a certain class of unitary transformations. L. INFELD AND J. PLEBAŃSKI. *Acta phys. Polon.*, **14**, *No.* 1–2, 41–75 (1955).

A study of linear unitary transformation which can be applied to co-ordinate and momentum operators. Since these operators behave like two components of a covariant spinor with respect to unimodular transformations, a formalism is developed and a notation is introduced analogous to that used in the spinor calculus. A linear group of transformations τ and a group of linear homogeneous transformations τ_h are introduced. Representations of unitary operators are made leading to given transformations from τ_h. A discussion of the use of general unitary operators of the form e^{iT} is given, T being a quadratic form in the momentum and co-ordinate operators, which lead to certain transformations from τ. An explicit form for the operator e^{iT} is formed leading to a given transformation of τ. A transformation group induced by τ_h is discussed for three real operators which are the quadratic forms in co-ordinate and momentum operators (physically identical with the Hamiltonian, the Lagrangian and the action function of a harmonic oscillator respectively). This group proves to be identical with L_3, i.e. with the restricted Lorentz group acting in a three-dimensional Minkowski space. The possibility of reduction of quadratic forms in co-ordinates and momenta to each of the three possible canonical forms, effected by means of linear unitary transformations, is discussed. A simple method is given for finding the eigenvalues of an operator which is a general elliptic quadratic form in the co-ordinates and momenta. Finally by specializing the general theory of the preceding sections a detailed discussion of a number of particular unitary transformations and the corresponding unitary operators is given; at the same time the rules for applying these operators to state vectors are deduced. The formulae are useful computations directly performed on operators appearing in various quantum mechanical problems. In the last section the question of composing linear transformations and the corresponding unitary operators is discussed. A.

517.37 : 538.1

9350. A new vector transformation of a curvilinear integral into a surface integral and its application in magnetostatics. É. DURAND. *C.R. Acad. Sci.* [*Paris*] **241**, *No.* 7, 594–6 (*Aug.* 17, 1955) In French.

The transformation is

$$\int_C \mathrm{A}_x d\mathrm{r} = \iint_S \{\mathrm{n}(\nabla.\mathrm{A}) - (\mathrm{n}.\nabla)\mathrm{A} - \mathrm{n}_x(\nabla_\lambda \mathrm{A})\} dS.$$

R. A. NEWING

518.4

9351. Tracer-type instrument for changing scales in two mutually perpendicular directions. F. FREUDENSTEIN AND P. CALCATERRA. *Rev. sci. Instrum.*, **26**, *No.* 9, 866–9 (*Sept.*, 1955).

An instrument using linkages is described by means of which curves can be redrawn to different scales. The scale size in each of two mutually perpendicular directions can be varied independently and continuously within a certain range. In operation one point of the instrument traces the original curve while a second point on the instrument traces the changed curve. The scale change can be varied between a 2 : 1 reduction and a 20 : 1 magnification. The size of the changed curve is not less than $8\frac{1}{2} \times 11$ in. and can be as large as 11×22 in. depending on the setting, the instrument itself measuring not less than 40×60 in. A.

518.5 : 621.372.5 : 621.317.79

9352. The use of electronic analogue computers with resistance network analogues. W. J. KARPLUS. *Brit. J. appl. Phys.*, **6**, *No.* 10, 356–7 (*Oct.*, 1955).

A method is described whereby conventional d.c. electronic analogue computing units are used in conjunction with a resistance network to solve partial differential equations. These computing units are connected to the network nodes and supply automatically the required feed-in currents. The procedure eliminates iterative or trial-and-error adjustments, without impairing appreciably the high accuracy obtainable with resistance network analogues. A.

519.2

9353. An approximate joint probability distribution for wave amplitude and frequency in random noise. R. A. WOODING. *New Zealand J. Sci. Technol. B*, **36**, *No.* 6, 537–44 (*May*, 1955).

An approximate joint probability distribution of instantaneous wave amplitude and frequency, for random sampling from continuous-spectrum random-noise records, is derived in terms of the joint distribution of the modulus of a vector representing the wave envelope and its angular velocity. The derivation involves a complex representation of the wave envelope which may not have been published previously. A.

519.2

9354. Regenerative stochastic processes. W. L. SMITH. *Proc. Roy. Soc. A*, **232**, 6–31 (*Oct.* 11, 1955).

A wide class of stochastic processes, called regenerative, is defined, and it is shown that under general conditions the instantaneous probability distribution of such a process tends with time to a unique limiting distribution, whatever the initial conditions. The general results are then applied to "S.M.-processes," a generalization of Markov chains, and it is shown that the limiting distribution of the process may always be obtained by assuming negative-exponential distributions for the "waits" in the different "states." Lastly, the behaviour of integrals of regenerative processes is considered and, amongst other results, an ergodic and a multi-dimensional central limit theorem are proved. A.

519.2 : 522

9355. Group-sequence criterion for series of observations. T. GÖKMEN. *Rev. Fac. Sci. Univ. Istanbul C*, **19**, *No.* 3, 171–92 (*July*, 1954).

The criterion decides whether the elements of a

series of observations are arranged at random or not. The group-sequence and the length of a group-sequence are defined, and it is shown that in a sequence with infinite number of elements, the mean length of group-sequence is $g/(g-1)$ where g is the number of groups into which the elements of the sequence are divided. For the application of this criterion to sequences with finite elements, the mean error of the mean length of a group-sequence is calculated and is found to be $g = \pm 1/(g-1)\sqrt{(g/G)}$ where G is the number of the group-sequences in the sequence studied. A.

ASTRONOMY . ASTROPHYSICS . GEODESY 52

522.2 : 535.317.25

The resolving power of astronomical observing instruments treated by Fourier analysis. *See Abstr.* 9537

522.61

9356. The possibility of discovering nebulae and faint stars. A. LALLEMAND AND M. DUCHESNE. *C.R. Acad. Sci.* [*Paris*] **241,** *No.* 4, 360–2 (*July* 25, 1955) In French.

Limitations of present photographic methods in current use with the largest telescopes are discussed; and it is suggested that, because of its relatively high sensitivity to photo-electrons, very high resolution, and virtual absence of granularity, Kodak Maximum Resolution emulsion should be of great value in satisfactorily recording photo-electron images of very faint astronomical objects, otherwise undetectable. Exposure times would be comparable to those required with standard techniques. D. R. BARBER

522.615 : 523.72

9357. An adjustable very narrow band-pass filter after the principle of the Pérot–Fabry interferometer. G. RAOULT AND J.-C. PECKER. *C.R. Acad. Sci.* [*Paris*] **241,** *No.* 1, 25–7 (*July* 4, 1955) In French.

Describes a 10-stage feedback amplifier to be used in measuring polarized light from solar corona.

J. M. C. DUKES

522.9

9358. Temperature fluctuations in the tube of an astronomical telescope. J. RÖSCH. *J. Phys. Radium,* **16,** *No.* 7, 54 S–56 S (*July*, 1955) In French.

See also Abstr. 8834 (1954).

522.9

9359. Relation between the structure of stellar shadow band patterns and stellar scintillation. G. KELLER. *J. Opt. Soc. Amer.,* **45,** *No.* 10, 845–51 (*Oct.*, 1955).

Difficulties are encountered in attempting to obtain an instantaneous picture of the pattern of stellar shadow bands seen on the surface of a telescope objective. There is a close statistical relationship between these patterns and the scintillation of the total starlight received. By observing scintillation through a diaphragm having two holes with variable separation between them one can derive the Fourier spectrum of periodicities in the shadow pattern and the autocorrelation function of the pattern. A number of patterns and associated autocorrelation functions are illustrated. Some remarks are then made on the correlation between the scintillation of close double stars and the influence of telescope aperture upon it. Finally the analysis is generalized to show how a frequency analysis of the scintillation can yield a space–time autocorrelation function. A.

522.9

9360. Determination of shadow band structure from stellar scintillation measurements. W. M. PROTHEROE. *J. Opt. Soc. Amer.,* **45,** *No.* 10, 851–5 (*Oct.*, 1955).

The autocorrelation functions of the light intensities in stellar shadow bands have been determined for two nights in March, 1954. These functions show that the stellar shadow bands are correlated over a distance of eleven inches, the limit to which observations were made; that the predominant element size is of the order of 5 to 10 in.; and that the pattern elements are elongated in the direction of motion of the pattern. The pattern appears to have a translational motion which correlates both in direction and magnitude with atmospheric wind velocities in the neighbourhood of the 200 mb level. A.

523.161

9361. On the condensation of *H* I regions. R. EBERT. *Z. Astrophys.,* **37,** *No.* 4, 217–32 (1955) In German.

The instability of the interface between the *H*I and *H*II regions around O associations may result in pockets of *H*I becoming embedded in the *H*II region. The possibility that such a pocket may become sufficiently compressed by pressure for gravitational contraction to set in is investigated. It is concluded that such contraction could occur in the case of a spherical pocket provided the mass enclosed exceeded a certain limiting value. The question of energy radiation during the contraction process is examined.

R. A. NEWING

523.164

9362. Radio-frequency radiation from the Rosette nebula. H. C. KO AND J. D. KRAUS. Letter in *Nature* [*London*] **176,** 221–2 (*July* 30, 1955).

A radio source with position and angular diameter agreeing with those of the nebulosity surrounding NGC 2244 has been observed on 242 Mc/s, with an apparent black-body temperature of 200°K. Assuming thermal emission by free-free transitions, an electron density of 9 cm^{-3} is deduced, essentially in agreement with estimates from optical data.

M. W. OVENDEN

523.164

9363. A fluctuating celestial radio source at 242 megacycles per second. J. D. KRAUS, H. C. KO AND D. V. STOUTENBURG. *Nature* [*London*] **176,** 304–5 (*Aug.* 13, 1955).

The fluctuations have a period of a few minutes, the intensity varying by a factor of about 6. The fluctuations are not always present, and no correlation of

occurrence could be found either with the normal diurnal scintillation variation, or with solar activity. Occasionally, large peaks resembling solar flare bursts are observed. It is suggested that the source (R.A. $08^h\ 19^m \pm 1^m$; Dec. $+8° \pm 3°$) may be a new type of radio source of stellar dimensions. M. W. OVENDEN

523.165

9364. On the motion of charged particles in weakly varying magnetic fields. G. HELLWIG. *Z. Naturforsch.*, **10a**, *No.* 7, 508–16 (1955) In German.

The motion is treated as a perturbation of motion in a uniform field. The method permits an extension of Alfvén's approx. equations to a second-order approximation and to relativistic motions.

R. A. NEWING

523.32

9365. Lunar radiation at 3 000 Mc/s. K. AKABANE. *Proc. Japan Acad.*, **31**, *No.* 3, 161–5 (*March*, 1955).

The radiation was observed with the 10 metre reflector of the Tokyo Astronomical Observatory, and results obtained for the temperature distribution over the lunar disk. A.

523.51

9366. The ages and origin of meteorites. P. REASBECK AND K. I. MAYNE. *Nature* [*London*] **176**, 186–8 (*July* 30, 1955).

Ages of some stone meteorites determined by the helium method are shown to be in substantial agreement with the ages of the same meteorites determined by the argon–potassium method, indicating that diffusive loss of helium is unimportant. The ages are within the range $0{\cdot}5-4\times10^9$ years, in general agreement with ages derived for stones by the isotopic lead content. The ages of iron meteorites derived by the helium method are less ($2-4\times10^8$ years). This difference is believed to be significant, and its relevance to the problem of the origin of meteorites is discussed. A planetary origin for all meteorites seems attractive, the planet having undergone a cataclysmic break-up after the solidification of the bulk of the iron phase.

M. W. OVENDEN

523.74

9367. The integro-exponential functions and the integral equation of centre–limb darkening of the sun. J. WARZÉE. *Bull. Acad. Roy. Belgique Cl. Sci.*, **41**, *No.* 6, 643–52 (1955) In French.

The source-function is taken to be of the form $B(\tau) = a_0 + a_1\tau - a_2E_2(\tau) - a_3E_3(\tau) - \ldots$, where $E_n = \int_1^\infty \frac{e^{-\tau x}}{x^n}\,dx$. The coefficients a_i can be found from the observed intensities emerging at various angles from the atmosphere, solving by least squares. Tables of E_n and of certain coefficients arising in the solution are given. In a previous paper [Abstr. 6698 (1955)] the form of the representation of $B(\tau)$ was different for $0 \leqslant \tau \leqslant 0{\cdot}2$ from that for $\tau > 0{\cdot}2$. If the observed intensities are known to only 3 significant figures, the dual representation gives more consistent results, as is shown both for an atmosphere in radiative equilibrium and for the actual solar atmosphere. The method of unique representation would be valuable if the observed intensities were known to 4 significant figures. M. W. OVENDEN

523.746

9368. The asymmetry of the sunspot curve. W. GLEISSBERG. *Rev. Fac. Sci. Univ. Istanbul C*, **19**, *No.* 3, 219–27 (*July*, 1954) In German.

A new definition is given by the following equation: $A_1 = (U-T)/(U+T)$, where T denotes the interval from minimum to maximum and U the interval from maximum to the next minimum. The values of this asymmetry are given for all eleven-year cycles since the time of Galileo, and show, on an average, a progressive increase. This increase can be eliminated by using the following formula: $A_1' = A_1 - 0{\cdot}0122(n+6)$ where n denotes the number of the eleven-year cycle in the Zürich numbering. The secularly smoothed values of A_1' reveal the eighty-year solar cycle. This may be considered as proving the reality of the progressive increase of the asymmetry of the eleven-year solar cycles since the time of Galileo. A.

523.746

9369. On the classification of sunspot groups. W. GLEISSBERG. *Rev. Fac. Sci. Univ. Istanbul C*, **19**, *No.* 4, 316–25 (*Oct.*, 1954) In German.

The Zürich system of classifying the sunspot groups according to their stage of development is investigated by comparing the results of this classification at the observatories of Zürich and Istanbul during the years 1952 and 1953. It is concluded that a modification of the Zürich system of classifying the sunspot groups according to their stage of development could be considered as practically perfect. A.

523.746

9370. Observations of solar spots in 1954. E. BALLI. *Rev. Fac. Sci. Univ. Istanbul C*, **20**, *No.* 1, 8–11 (*Jan.*, 1955) In French.

Heliographic co-ordinates, and epochs of first and last appearance are tabulated for 52 spot-groups observed on 292 days during 1954. D. R. BARBER

523.75

9371. Variation of the absolute surface brightness in the corona with the solar cycle. W. N. ABBOTT. *Ann. Astrophys.*, **18**, *No.* 2, 81–91 (1955).

Photometric measurements of isophotes and of total coronal intensities during eclipses were used to derive, by a method hereunder described, the absolute surface brightness of the isophotes. On discussion certain relations appear between the mean distance, ρ_m, of the isophote to the limb and its absolute surface brightness, depending on the phase in the solar cycle. This empiric relation indicates that the ρ_m of a given absolute surface brightness varies more within a zone between $\rho_m = 1{\cdot}0\ R_\odot$ and $2{\cdot}0\ R_\odot$ the variation tending towards zero near the chromosphere and at $\rho_m = 3{\cdot}8\ R_\odot$, which may be taken as the inner limit of the F corona. The ratio B_{max}/B_{min} (B_{max} = absolute surface brightness at maximum, and B_{min} = absolute surface brightness at minimum) varies, being maximum in the vicinity of the chromosphere and equal to unity at $\rho_m = 3{\cdot}8\ R$. A.

523.75 : 532.51 : 538.56 : 550.383.3

9372. Hydromagnetic dynamo models. E. N. PARKER. *Astrophys. J.*, **122**, *No.* 2, 293–314 (*Sept.*, 1955).

Investigates the steady-state amplification of magnetic fields in a fluid. It is shown that a rotating

sphere of conducting fluid can regenerate a dipole magnetic field. It is sufficient for the angular velocity of rotation to vary with distance from the axis of rotation and for cyclonic fluid motions to be present. The nonuniform rotation generates a toroidal field from the dipole field; the cyclones generate, from the toroidal field, loops of flux in the meridional plane which coalesce to amplify the dipole field. The rotating sphere is discussed in relation to the liquid core of the earth and the geomagnetic dipole field. If, instead of a rotating sphere, one has a prismatic volume of fluid, it is possible to construct migratory dynamo waves. The dynamo waves are discussed in relation to the solar convective zone; it is shown that such waves can account for many of the principal features of the observed solar magnetic activity. A

523.75 : 550.385.41

9373. Solar prominences and geomagnetic disturbance. W. O. ROBERTS AND D. E. TROTTER. Note in *J. atmos. terrest. Phys.*, **6**, *No.* 5, 282–3 (*May*, 1955).

Superposed-epoch analyses of measurements of limb prominence areas show no significant trends with respect to either the most magnetically disturbed days or the quiet days. This disagrees with Kiepenheuer's suggestion [Abstr. 2761 (1947)], based on an analysis of dark filament areas, that the solar *M*-regions be identified with the large quiescent prominences found at intermediate and high solar latitudes. G. M. BROWN

523.752

9374. A preliminary investigation of the small changes in the chromospheric structure. S. L. LIPPINCOTT. *Ann. Astrophys.*, **18**, *No.* 2, 113–17 (1955).

Explores the possibilities of obtaining a better insight into the small-scale changes of the chromosphere in a centre of activity through the use of photographs taken at short time intervals giving large scale portrayal in H_α radiation. The chromospheric structure around a sunspot group is characterized by fine dark line-structure oriented in such a fashion as to suggest the presence of a magnetic field. These dark lines are called in this paper "fibrilles," a name suggested by d'Azambuja. From this preliminary study of the photographs taken by Bernard Lyot at the Pic du Midi in 1942 it is found that an accuracy of 0·5″ in the position of small chromospheric patterns can be attained under optimum observing conditions. An average apparent velocity of the order of 7 km/sec is found for the change in position of the ends of the fibriles projected on the disk. There seems to be no general translation with time but rather a random fluctuation in position over a small area. It is difficult to determine the duration of the fibrilles for in certain instances one may disappear, but the same or a similar fibrille may appear in the same position some minutes later. This apparent disappearance and reappearance may be due to a number of causes: (1) the fibrille momentarily sinking to a level in the chromosphere outside the range of the centre of the H_α-radiation; (2) the same local conditions being maintained to produce another fibrille with similar contours; (3) or perhaps a spurious effect due to instrumental or seeing variations. During an interval of 45 minutes there is no observable change in the average orientation of the fibrilles in an arbitrarily chosen area of (25 000 km)^2 within the centre of activity. A.

523.755

9375. On the identification of Ca XV and A XIV in the solar corona. B. EDLÉN. *Monthly Not. Roy. Astron. Soc.*, **114**, *No.* 6, 700–3 (1954).

The interpretation of the coronal wavelengths λ5694 and λ5446 as transitions in Ca XV is shown to be compatible with known isoelectronic data on level intervals. The original suggestion concerning A XIV is revised and the identification transferred from λ4359 to the new coronal line λ4412. A.

523.755

9376. The structure of the solar corona at [sunspot] minimum. M. WALDMEIER. *Z. Astrophys.*, **37**, *No.* 4, 233–60 (1955) In German.

The quiet corona, at minimum phase of sunspot-activity, consists in two characteristic zones: the polar plumes, and the almost-featureless regions on either side of the solar equator, the two features being separated by a narrow belt of low-density atmosphere at 65°–70° heliographic latitude. Individual rays emanating from the polar zones have a mean lifetime of ~15 h. At the termination of the minimum phase, a new principal coronal zone emerges from the low-latitude boundary of each polar zone. Observation of the circulation pattern in light of wavelength, 5 303 Å, suggests that coronal material streams from these two principal zones, over the regions of prominence activity, into the polar zones. D. R. BARBER

523.755 : 535.331

Energy levels in Ca XV. *See Abstr.* 9548

523.774

9377. Contours of strong Fraunhofer lines. S. MIYAMOTO. *Publ. Astron. Soc. Japan*, **6**, *No.* 3, 140–9 (1954).

Characteristic features of the inner-wing contours of very strong Fraunhofer lines have been investigated. At the centre of the sun's disk the observed contours show a hump at the inner wing. This hump appears in the theoretical noncoherent contour. The residual intensity at this hump is related to the temperature gradient of the photosphere. For Mg b_1 5183·6, detailed comparison of theoretical contours with observation has been carried out. The noncoherent contour seems to give better fitting with observation than the coherent theory at the centre of the sun's disk, while the latter is more preferable to account for the centre-limb variation. A composite photospheric model, consisting of upper coherent layer and lower noncoherent layer was considered. A.

523.774

9378. Doppler core and inner wing of strong Fraunhofer lines. S. MIYAMOTO. *Publ. Astron. Soc. Japan*, **6**, *No.* 3, 150–61 (1954).

The high residual intensities at the centre of strong Fraunhofer lines are ascribed to fluorescence or to electron collision. In this paper, the influence of strong central emission on the inner wing and Doppler core contours was investigated. The emitted quanta at the line centre escape through the less opaque frequency region by the pressure or thermal redistribution. As a result, the Doppler core width is reduced to one-third of the corresponding coherent core width.

The observed core widths are about six times the Doppler half width at the solar photospheric temperature, irrespective of the strength of the lines. This fact is interpreted in terms of coherent theory as that the turbulence is not much larger than the thermal velocity of metallic elements throughout the photosphere. On the other hand, in terms of the non-coherent theory given in this paper, the same observational fact is interpreted as that the turbulence increases as the photosphere is ascended, and at the upper layer reaches a radial velocity of the order of 4·6 km/sec. A.

523.851

9379. The stability of a spherically symmetric cluster of stars describing circular orbits. C. GILBERT. *Monthly Not. Roy. Astron. Soc.*, **114,** *No.* 6, 628–34 (1954).

Some general properties are derived for a stationary system of many gravitating masses of a type described by Einstein some years ago. The system is assumed to give the average field and the average density of matter for a globular cluster of stars. It is shown that a particularly smooth join of the field within the cluster to the exterior field in free space can be made when the density of matter tends to zero at the boundary. Also the condition for the stability of the masses in their orbits is shown to place an upper limit to their velocities, which in most cases restricts the gravitational mass of the cluster to a value which is less than its rest mass. A.

523.852.22

9380. The photoelectric photometry of planetary nebulae. W. LILLER. *Astrophys. J.*, **122,** *No.* 2, 240–55 (*Sept.*, 1955).

The surface brightnesses of fourteen planetary nebulae and the lower limits of the magnitudes of their exciting stars have been determined photoelectrically. Both narrow-band interference filters as well as conventional glass and gelatin filters were used to sort out the desired nebular and central-star radiations. The nebular surface brightnesses are in excellent accord with the results of Liller and Aller, but all indications are that the photographic magnitudes compiled by Berman are systematically too bright. However, the central-star magnitudes listed by Berman are generally in accord with the photoelectric observations reported here. A.

523.87

9381. Associated absorption spectra in novae. C. E. R. BRUCE. *Rep. Brit. Elect. Res. Assoc., Ref. Z/T*85, 16 *pp.* (1952).

Examination of the spectral characteristics of novae suggests that one feature thereof is the close relationship which often exists between an absorption spectrum of low excitation and small displacement, and one of high excitation and larger displacement. An explanation for this association is afforded by the electrical discharge theory of novae, together with the writer's theory of the leader stroke of the lightning discharge. The core of arc discharge will radiate the spectrum of low excitation, while that of higher excitation will be emitted by the surrounding envelope of corona discharge. A new explanation is offered for the explosive outward movements of gas clouds in novae, and in the atmospheres of bright line stars, and for the apparently anomalous increase with wavelength of the displacements of the violet absorption components to which they often give rise. An explanation is also offered for the increase in intensity of the absorption components of the Balmer lines with decrease in wavelength. It is suggested that the quasi-periodic variation in magnitude experienced by many novae is due to the spiralling of the discharge, and the conclusion, derived from a study of its spectrum, that in Nova Aquilae 1918 the discharge took place in a plane containing the line of sight, would appear to be supported by photographs of the subsequent nebula taken in 1920. A.

523.87

9382. Combination spectra in long-period variable stars. C. E. R. BRUCE. *Phil. Mag.*, **46,** 1123–31 (*Oct.*, 1955). Based on *Rep. Brit. Elect. Res. Assoc., Rep. Z/T*101.

The electrical discharge theory of the variation in excitation observed in the atmospheres of the long-period variable stars offers an explanation for the combination spectra exhibited by many of these stars, which is in accord with several of the most outstanding changes in their spectra and magnitude. A.

523.877

9383. On the stability of the atmospheres of helium stars. S. KOYAMA. *Publ. Astron. Soc. Japan,* **6,** *No.* 3, 162–72 (1955).

On the basis of the hypothesis that the highly luminous peculiar stars are gravitationally contracting after they have exhausted their hydrogen, the stability of the upper atmosphere, assumed to consist of pure helium, against the radiation pressure is considered. The criterion curves which indicate the deviation from the stable distribution are plotted in the (log of surface gravity, effective temperature)-diagram. In transforming the observed (bolometric magnitude and effective temperature), into (surface gravity and effective temperature), the Salpeter reactions were assumed to set in when the central temperature of contracting stars reaches the required degree. Most of the nuclei of planetary nebulae fall in the region of radiative instability, which may suggest that the streaming out atmospheres or nebulous shells can be attributed to radiation pressure. A.

523.877

9384. Study of wave propagation in the generalized Roche model. R. SIMON. *Ann. Astrophys.*, **18,** *No.* 2, 92–9 (1955) In French.

Discusses the propagation of a radial perturbation through the envelope of a generalized Roche model, the surface of the core acting as a piston. When the equations may be linearized, an explicit solution can be found for certain values of the parameters. A.

523.877

9385. Note on Whitham's "The propagation of weak spherical shocks in stars." D. S. JONES. *Proc. Cambridge Phil. Soc.*, **51,** *Pt* 3, 476–85 (*July*, 1955).

Mathematical considerations of the conditions under which an expression used in the theory of Whitham [Abstr. 5238 (1954)] is valid. Different series are developed which are similar to but not identical with those given by Whitham. G. M. BROWN

523.877

9386. Axial rotation and stellar evolution. A. R. SANDAGE. *Astrophys. J.*, **122**, *No.* 2, 263–70 (*Sept.*, 1955).

Some of the current ideas of stellar evolution are tested by using Arne Slettebak's homogeneous data on the rotational velocities of stars. The values of $V \sin i$ for stars not now on the main sequence are shown to be consistent with the idea that these stars were once main-sequence objects but have moved into the giant and supergiant region of the M_{bol}, log T_e plane by an evolutionary process. In particular, the data are entirely consistent with the evolutionary tracks computed by M. Schwarzschild and his collaborators. A.

523.877

9387. Stellar evolution and the synthesis of the elements. W. A. FOWLER, G. R. BURBIDGE AND E. M. BURBIDGE. *Astrophys. J.*, **122**, *No.* 2, 271–85 (*Sept.*, 1955).

The production of neutrons in stellar interiors will occur through exoergic (α, n) reactions on O^{17}, Ne^{21}, Mg^{25}, and Mg^{26} as well as on C^{13}, as first suggested by Cameron. With these reactions as possible neutron sources, an attempt is made to indicate a general, but still qualitative, basis for the synthesis of the elements in stars. The importance of successive stages of interaction of the light nuclei with hydrogen and helium is stressed. In particular, the reaction $Ne^{20}(p, \gamma)Na^{21}(\beta^+)Ne^{21}$, followed by $Ne^{21}(\alpha, n)Mg^{24}$, is taken as the basis for alterations and modifications of the mechanisms of Hoyle and Cameron for the synthesis of the intermediate and heavy elements, respectively. The use of this reaction obviates some of the difficulties encountered in processes in which a small proportion of hydrogen must be mixed into the stellar core at temperatures at which it will be very rapidly consumed. A possible evolutionary scheme which is consistent with these element-building processes is outlined. It is supposed that the synthesis of the heavy elements will take place in stars which have reached the cool giant stage in their evolutionary path. The M as well as the S stars may be important in this connection. A rough estimate, based on the observed frequency of S stars, suggests that the rate of element synthesis in these stars is sufficient to produce the observed heavy-element abundances. Differences in chemical composition between population I, population II, and intermediate groups of stars are briefly discussed. A.

523.877

9388. The pulsational stability of models for red giant stars. J. P. COX. *Astrophys. J.*, **122**, *No.* 2, 286–92 (*Sept.*, 1955).

The pulsational stability of a typical red giant star model is examined. The phase delay in energy production by the carbon cycle is found to be negligible, of the order of 10^{-3} radians. The nuclear reactions in the central regions are further shown to have a negligible effect on the maintenance of pulsations. The dissipation of pulsation energy by radiation losses is found, under the usual assumptions, to yield a damping time of about 10 days for the pulsations. It is therefore concluded that if the cepheids are represented by the centrally concentrated red giant models, the cause of the pulsations must be sought in the outer 15% of the stellar radius, where many of the usual approximations are not valid. A.

523.877

9389. On the *X*- and *Y*-functions of S. Chandrasekhar. I. W. BUSBRIDGE. *Astrophys. J.*, **122**, *No.* 2, 327–48 (*Sept.*, 1955).

The dual integral equations for the *X*- and *Y*-functions are first reduced to separate singular integral equations for the functions $\xi(\mu) = X(\mu) + Y(\mu)$ and $\eta(\mu) = X(\mu) - Y(\mu)$. These are then reduced to Fredholm equations, and the resulting Neumann series are shown to converge for all sufficiently large "optical depth" τ, thus establishing the existence of $X(\mu)$ and $Y(\mu)$ for all sufficiently large τ. A.

523.877 : 523.76

9390. On tubes of magnetic force embedded in stellar material. E. JENSEN. *Ann. Astrophys.*, **18**, *No.* 2, 127–40 (1955).

Magnetic fields are introduced in the form of thin straight or toroidal tubes of force. The form of the magnetic field is supposed to be identical with the most persistent mode of a cylindrical decay field. The existence of magnetic fields of this type in pressure equilibrium with the surrounding matter leads to a density-depression within the tube. Since the density can never be less than zero, this gives further an upper limit to the magnetic field of this type which can exist at a given pressure. The maximum value of the field is found under the assumption of a straight infinite tube of force. Assuming, however, that the thickness of the tube is much smaller than the distance from the stellar centre, applications are made to stellar interiors. The limit found in this way agrees well with that derived by Chandrasekhar and Fermi from the virial theorem. Next, the variations of the magnetic field intensity and the radius of the tube when it is displaced to regions of different physical conditions are calculated. The cases considered are a straight tube of force and a toroidal tube. Thirdly, a toroidal tube under gravity is discussed. It appears that in current stellar models such a tube of force will always have a tendency to float to the surface because of too large density and temperature gradients. Thus if the picture of a "reservoir" of magnetic fields below the photosphere is maintained to describe the sunspot phenomena, other forces or other types of fields than those considered here must be involved. Finally it is pointed out that as a consequence of the density-depression one would expect the sun to have a larger radius at sunspot maximum than at sunspot minimum. A.

PHYSICS 53

53

9391. Proceedings of the International Conference of Theoretical Physics. *Tokyo: Science Council of Japan* (1954) 942 *pp.*

Report of a conference held in Kyoto and Tokyo, September, 1953, under the auspices of the International Union of Pure and Applied Physics. Contains a record of the lectures and discussions of the main sessions and some of the informal meetings. The following list includes all the lectures but omits "introductory talks" and "informal meetings."

Field Theory A—Non-Local Theory:—H. Yukawa: An Attempt at a Unified Theory of Elementary Particles. C. Møller: On the Problem of Convergence in Non-Local Theories. R. E. Peierls: Field Theories with Non-Local Interactions.

Field Theory B—Miscellaneous Problems:—K. Nishijima: Many-Body Problem in Quantum Field Theory. H. Suura: On a Treatment of Many-Body Problem in Quantum Field Theory. W. Heitler: Exact Theory of Line Breadth.

Symposium on Cosmic Rays A—Time Variation of Cosmic-Ray Intensity:—M. S. Vallarta: On the Albedo Effect of Cosmic Rays. Y. Sekido: On the Cosmic-Ray Storms. J. A. Wheeler: The Origin of Cosmic Rays.

Symposium on Cosmic Rays B—Miscellaneous Problems:—H. J. Bhabha: High-Altitude Measurements of Intensity of Cosmic Radiation. H. J. Bhabha: Investigation of Heavy Mesons by Means of a Solid Emulsion Block. K. A. Brueckner: The Disintegration Schemes of Neutral *V*-Particles. E. Amaldi: Underground Experiment in Europe. J. Nishimura and K. Kamata: Theory of Air Shower. T. Oshio: Studies on the Cosmic Rays Underground. G. Fujioka: Observation of Lateral Spread of Air Showers.

Cosmic Rays and *V*-Particles:—H. J. Bhabha: Summary of the Bagnères de Bigorre Conference Report. R. E. Marshak: Report on Cosmotron Experiments. C. N. Yang: Report on Cosmotron Experiments. H. J. Bhabha: On Multiple Meson Production. W. Heitler and C. Terreaux: On Cosmic-Ray Jets. A. Pais: ω-Space Theory.

Pions:—G. Wentzel: Summary of Recent Experimental Work on the Pion-Nucleon Scattering. C. N. Yang: Recent Experimental Results at Brookhaven. R. E. Marshak: Recent Experiments on Pion-Nucleon Scattering at Lower Energy. N. Fukuda: Theoretical Analysis of Pion-Nucleon Scattering. M. Lévy: On the Charge-Dependence of *S*-Phase Shifts of Pion Scattering. K. A. Brueckner: Some Aspects of Meson-Nucleon Interaction. K. Aidzu: A Remark on the Relation between Pion-Nucleon Scattering and Photomeson Production.

Intermediate and Strong Coupling Theory:— G. Wentzel: Recoil Effects in the Strong Coupling Theory. S. Tomonaga: Intermediate Coupling Theory of Pion-Nucleon Scattering. K. Sawada: Variational Treatment of Pion-Nucleon Interaction. L. I. Schiff: Lattice Quantization of Non-Linear Field Theory.

Nuclear Forces:—R. E. Marshak: Recent Work on Nuclear Forces in Rochester. M. Taketani: Studies on Nuclear Forces in Japan. K. A. Brueckner: Nuclear Forces in Pseudoscalar Meson Theory. M. Lévy: Nuclear Forces of Ps-Ps Theory. K. Sawada: A Relation between Taketani's Treatment and Brueckner's One. H. Hasegawa: Tomonaga's Approximation in the Nuclear Force.

Nuclear Reaction:—R. E. Peierls: Report on the Conference of Birmingham. J. A. Wheeler: Collective Model for Nuclei. S. Hayakawa: Theory of *d-p* Reaction. Y. Fujimoto: Deuteron Reactions. L. I. Schiff: Interpretation of Electron Scattering Experiments. P. Huber: Confirmation of the Polarization of Neutrons from the (d, d)-Reaction. C. Bloch: On the Theory of Nuclear Level Density.

Shell Structure and β-Decay:—M. G. Mayer: Review of Shell Structure. M. Umezawa: A Note on Nuclear Moments. S. Nakamura: Nuclear Structure and β-Decay. E. P. Wigner: Note on the β-Decay. Y. Tanikawa: On the Interaction Forms of the β-Decay.

Polymers:—P. J. Flory: The Configuration and Properties of Polymer Molecules in Dilute Solution. J. G. Kirkwood: The Theory of Visco-Elastic Properties of High Polymers. I. Prigogine: On the Statistical Theory of Polymers and Polymer Solutions. A. Isihara: Statistical Mechanics of Rubber Elasticity. E. Teramoto: Statistical Theory of Chain Molecules.

Liquids:—J. E. Mayer: Theoretical Treatment of Liquids. J. G. Kirkwood: The Statistical Mechanical Theory of the Liquid State. A. Harasima: Statistical Mechanics of Surface Tension.

Transport Phenomena:—J. de Boer: Quantum Theory of Transport Phenomena. S. Ono: Quantum-Statistical Theory of Transport Phenomena. T. Yamamoto: Statistical Mechanics of Irreversible Phenomena. I. Prigogine: On the Statistical Mechanics of Irreversible Processes. H. Mori: On the Statistical Mechanics of Time-Dependent Phenomena.

Irreversible Processes:—I. Prigogine: On Some Aspects of Thermodynamics of Irreversible Processes. H. Takahasi: Statistical and Formal Theories of Thermal Fluctuation. N. Hashitsume: Thermal Fluctuations in Linear Dissipative Systems.

General Methods in Statistical Mechanics:—J. de Boer: Quantum Properties of the Condensed State [see Abstr. 9465 (1955)]. K. Husimi: Statistical Mechanics of Condensation. S. Katsura: On the Theory of Co-operative Phenomena. K. Ikeda: On the Theory of Condensation. M. N. Rosenbluth and A. W. Rosenbluth: Further Results on Monte Carlo Equations of State.

Crystal Dislocation:—N. F. Mott: Difficulties in the theory of Dislocations. T. Suzuki and H. Suzuki: Dislocation Networks in Crystals. R. R. Hasiguti: Internal Friction of Metals due to Crystal Imperfections. F. Seitz: On the Theory of the Kirkendall Effect.

Molecules:—P. O. Löwdin: Recent Simplifications in the Molecular Orbital Theory of Calculating Energy Levels. J. C. Slater: Work on Molecular Theory in the Solid-State and Molecular Theory

Group at M.I.T. R. S. Mulliken: Intermolecular Charge-Transfer Forces.

Metals:—C. A. Coulson: A New Approach to the Theory of Electrons in Solids. J. H. Van Vleck: The Cohesive Energies of Alkali Metals. E. P. Wigner: Qualitative Theory of the Cohesion in Metals. A. Morita: Band Structure of Semi-Metals. L. Onsager: Diamagnetism in Metals. R. E. Peierls: On Diamagnetism of Metals.

Electron Theory of Intrinsic Magnetization:—J. C. Slater: Problem of Ferromagnetism. T. Matsubara and T. Yokota: Band Theory of Antiferromagnetism.

Antiferro- and Ferrimagnetism:—L. Néel: Ferri- and Antiferromagnetism. T. Nagaat: Ferrimagnetism in Nature. H. Watanabe: The Temperature Dependence of Susceptibilities of Ferrites on the Basis of the Theory of Ferrimagnetism. T. Okamura: Resonance Absorption in Ferrites. T. Nagamiya: Antiferromagnetism of $CuCl_2.2H_2O$. K. Yosida and T. Moriya: The Origin of the Anisotropy Energy of $CuCl_2.2H_2O$.

Magnetic Resonance:—N. Bloembergen: Magnetic Relaxation in Solids. T. Muto: On the Mechanism of the Nuclear Spin-Lattice Relaxation in Solids. R. Kubo and K. Tomita: Broadening in Nuclear Magnetic Resonance Absorption. H. Kumagai: Resonance Absorption Experiments of Paramagnetic Salts. K. Tomita: Frequency Dependence of Paramagnetic Resonance in $K_2CuCl_4.2H_2O$. S. Koide and T. Usui and K. Kambe: Resonance Line Width in the Paramagnetic Single Crystal $K_2CuCl_4.2H_2O$.

Dielectrics:—H. Fröhlich: Electrons in Dielectrics. H. Kawamura: On the Electric Conduction of Dielectrics under Strong Electric Field. J. Yamashita: The Quantum Theory of Dielectrics. K. S. Krishnan: Polarization Field in Ionic Crystals. Y. Takagi: Ferroelectricity and Antiferroelectricity of Some Ionic Crystals.

Colour Centres:—F. Seitz: Theory of Color Centers in the Alkali Halides. Y. Uchida and M. Ueta: Recent Experiments on Colour Centres. Y. Uemura, T. Inui and Y. Toyozawa: Theory of the Electronic Structure of Colour Centres. T. Nagamiya, T. Kojima, T. Moriya and J. Kanamori: Wigner-Seitz Method Applied to *F*-Centre.

Liquid Helium:—C. J. Gorter: Some Recent Data on Liquid Helium. S. Nakajima: Review of the Recent Work in Japan on the Two-Fluid Theory of Liquid Helium. R. P. Feynman: Atomic Theory of Liquid Helium. T. Nishiyama and K. Kamiya: On Energy Spectra of Helium II.

Superconductivity:—H. Fröhlich: Remarks on the Theory of Superconductivity. S. Hayakawa, Y. Kitano, S. Nakajima and H. Nakano: Remarks on the Electron-Lattice Interaction. Y. Kitano: On the Phase Transition of the Electron-Lattice Vibration System. M. Toda: On the Theory of Superconductivity. H. Ichimura: Statistical Mechanics of Electron-Lattice System.

53 : 37

9392. Critique of teaching objectives in secondary schools. H. E. Wise. *Amer. J. Phys.*, **23**, *No.* 7, 415–23 (*Oct.*, 1955).

To increase the supply of potential physicists, it is suggested that emphasis be placed on the better preparation of teachers and on securing their continuing tenure on a 12-months basis at salaries comparable to those paid in professions requiring similar ability and preparation. To accomplish these ends, it is suggested that high school science and mathematics teaching be placed under Federal regulations somewhat similar to those which now govern Vocational Agriculture and Home Economics under the Smith–Hughes Law. A.

53 : 37

9393. Effectiveness of the Case–General Electric science fellowship program for high school physics teachers. L. O. Olsen and R. W. Waite. *Amer. J. Phys.*, **23**, *No.* 7, 423–7 (*Oct.*, 1955).

The impact of the programme on the training of scientific and engineering personnel through advanced training of physics teachers is discussed. An indication of the general problems faced by teachers in their respective schools is set down, along with specific examples of improved teaching. A.

53 : 37

9394. Teaching aids: equipment and facilities. V. E. Eaton. *Amer. J. Phys.*, **23**, *No.* 7, 428–9 (*Oct.*, 1955).

The formation and work of the AAPT Committee on Scientific Apparatus for Educational Institutions is described. Many suggestions are made for increasing the variety and appeal of apparatus used in teaching physics, with the ultimate objective of increasing student interest in the subject, and of meeting the growing demand for research physicists and physics teachers. A.

53 : 37

9395. One-semester physics course for liberal arts students. R. A. Peck, Jr and W. E. Haisley, Jr. *Amer. J. Phys.*, **23**, *No.* 7, 440–9 (*Oct.*, 1955).

Holton's admirable general education text was employed to organize the study and define its semi-humanistic approach. Equal attention was directed to a tightly integrated core of technical physics and to the interplay between science and the social environment. Technical material was organized about Newton's synthesis in mechanics and Bohr's in atomic structure. For the role of physics in human affairs subject-matter was drawn from outside reading in selected historical and philosophical expositions and brought into the course through written papers and symposia. The customary laboratory curriculum was modified to provide a gradual increase in pace and difficulty throughout the semester. A.

53 : 93

9396. History and the physicist. H. Kondo. *Amer. J. Phys.*, **23**, *No.* 7, 430–6 (*Oct.*, 1955).

There are five major reasons why the physicist should know and be interested in the history of physics: (1) the great physicists have left us in their writings a treasure containing valuable suggestions for future laws, principles, theories and experiments; (2) it is necessary to know why theories are now, or have been, discarded and are in disrepute: frequently a hostile scientific atmosphere may have been the sole reason why an important theory was rejected in the past; (3) in physics, many historical theories have been revived and applied anew; (4) the original historical arguments given in support of a theory may be invalid; and (5) physicists can often obtain inspiration by studying the lives of great men. A.

53.081.4

9397. Units of weight and measure (United States customary and metric). Definitions and tables of equivalents. L. V. JUDSON. *Misc. Publ. Nat. Bur. Stand., No.* 214, 64 *pp.* (1955).

The units of length, area, volume, capacity and mass in use in the United States are defined. Tables of interrelation and tables of equivalents for these units in the metric system and in the U.S. customary system are given. There is a section in which the fundamental equivalents are stated, one containing the approved spelling and abbreviation of each of the most common units of weight and measure, and one showing the status of the metric system in the United States. All of the tables and other material conform to the definitions, equivalents and usages current at the date of issue. The conversion tables are confined to simple units, excluding all compound units such as foot-pounds, pounds per cubic foot and feet per second. A.

53.085.34

9398. A photoelectric light-spot-displacement detector. Å. THULIN. *J. sci. Instrum.*, **32,** *No.* 10, 387–90 (*Oct.*, 1955).

The detector described employs a differential cadmium sulphide photoconductive cell connected in a bridge circuit. The use of a stabilized current for supplying the bridge permits a linear calibration that is independent of variations in spot intensity and photosensitivity. The output current is sufficient for operating pointer micro-ammeters or sensitive pen recorders without amplification. Theoretical and practical results are given. A.

FUNDAMENTALS .530.1

530.12

9399. On the gravitational self-energy of a particle in classical field theory. A. A. BORGARDT. Letter in *Zh. éksper. teor. Fiz.*, **28,** *No.* 3, 377 (1955) In Russian.

Discusses the self-energy of a Bopp–Podolsky and a Born–Infeld electron in the framework of the linear approximation to Einstein's gravitational equation.

J. M. RADCLIFFE

530.12

9400. On Gödel's cosmological solution of Einstein's gravitational field equations. S. PATNAIK. Letter in *Curr. Sci.*, **24,** *No.* 7, 224–5 (*July*, 1955).

530.12

9401. Classical theory of fields. R. CHENON. *C.R. Acad. Sci.* [*Paris*] **241,** *No.* 2, 166–7 (*July* 11, 1955) In French.

The Poisson bracket of two "surface-independent" quantities can be defined in a covariant way without the use of the canonical formalism. "Anti-Poisson brackets" can be defined for complex field variables.

G. FIELD

530.12

9402. The effects of rotation of the central body on its planetary orbits, after the Whitehead theory of gravitation. C. B. RAYNER. *Proc. Roy. Soc. A*, **232,** 135–148 (*Oct.* 11, 1955).

The Whitehead gravitation tensor for the exterior field due to a finite, uniform rotating sphere is evaluated in closed form. The advance of perihelion of an equatorial orbit is then calculated, making no assumption as to the smallness of the angular velocity of the central sphere. Finally, the perturbing forces on the Newtonian elliptical orbit due to rotation of the central sphere are determined with neglect of the square of this angular velocity. It is remarkable that the results of the present paper based on Whitehead's theory agree very closely with those obtained by Lense and Thirring (1918) using Einstein's linearized law of gravitation. In fact, for a homogeneous sphere, it is impossible to distinguish between the results in the two theories, to the order of approximation considered. A.

530.12

9403. On the motion of charged particles in general relativity. B. BERTOTTI. *Nuovo Cimento* (*Ser.* 10) **2,** *No.* 2, 231–40 (*Aug.*, 1955).

Two problems are worked out, (*a*) the procedure for obtaining the self-reaction terms according to Einstein's method is greatly abbreviated by a dimensional consideration; (*b*) the problem of the motion of two charged particles is solved with the aid of the "geodesic method." A.

530.12

9404. Logical and philosophical foundations of the special theory of relativity. A. GRÜNBAUM. *Amer. J. Phys.*, **23,** *No.* 7, 450–64 (*Oct.*, 1955).

It is argued that the correct understanding and teaching of the special theory of relativity are still impaired by a number of specific, widespread misconceptions. To remove these, the relevant definitional, experimental and philosophical foundations of the kinematics of the theory are made explicit by reference to the following issues: (i) the relativity of simultaneity, which arises, in the first instance, within a single Galilean frame, (ii) the principle of the constancy of the speed of light, which rests on three distinct experimental facts as well as on an important convention, made possible by a fourth experimental result, (iii) the compatibility of the invariance of the speed of light with the absence of a retardation on the part of moving clocks, and the role of that optical principle in the deduction of the Lorentz transformations, (iv) the merits of the *ad hoc* charge against the Lorentz–Fitzgerald contraction hypothesis; the philosophical sources of the difference between Lorentz's and Einstein's interpretations of the transformation equations. A.

530.145

9405. Differential structure of non-local theories. II. J. RZEWUSKI. *Acta phys. Polon.*, **14,** *No.* 1–2, 121–34 (1955).

For Pt I, see Abstr. 7110 (1954). A differential description of non-local systems is obtained by replacing the original integro-differential equations containing integrals over space-time by equivalent integro-differential equations containing integrals over a space-like hypersurface only. These equations provide a description of the system which is local in time. The construction of the coefficients of the equation in question is carried out in the linear as well as in the general non-linear case. The calculations are illustrated by a particularly simple example. The

admissibility of form-factors containing poles in the Fourier representation (corresponding to multi-mass equations) is discussed. A.

530.145

9406. On Bloch and Nordsieck's divergence. R. Ascoli. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 3, 413–17 (*Sept.*, 1955).

The convergence of the expectation value $\bar{N}$ of the number of soft photons emitted by a given classical current is studied, using Bloch and Nordsieck's approximation. It is found that $\bar{N}$ is finite, whenever the particles producing the field are moving in a finite volume of space. Therefore in every experiment that can really be done the number of emitted photons is finite. Bloch and Nordsieck's divergence, which arises in the case of a charged particle undergoing a transition between two definite momentum states, corresponds to experimental conditions which cannot be reached in nature (an infinite volume of space is necessary). In the appendix a less stringent condition for the convergence of $\bar{N}$ is derived. A.

530.145

9407. On the meaning of bilocalizability. J. Rayski. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 2, 255–72 (*Aug.*, 1955).

An analysis of the foundations of quantum mechanics shows that two distinct procedures are involved therein: quantization of space-time, and the linking of a mechanical model to the quantized space-time (QST). The former is called *l*-quantization, the latter *h*-quantization for reasons explained. The point model of elementary particle is found to be rather unnatural while a bi-point model fits naturally into the framework of QST. Among the possible bi-point models a rotator model fitting smoothly to the covariance properties of QST is preferable. The rest mass of the bi-point particle is no more a parameter introduced *ad hoc* but is determined by the momenta of the internal motion of the particle. A bilocal field theory based on the bi-point (rotator) model of the elementary physical entity is constructed: field equations are set up as well as the current four-vector, energy-momentum tensor and angular momentum tensor densities satisfying differential conservation laws. The bilocal field may be quantized and describes a whole set (family) of particle sorts with higher spins and masses corresponding to the excited states of the underlying rotator model. There is a one-to-one correspondence between the particle types forming a family and the irreducible unitary representations of the group of rotations, which fact exhibits an intimate and complete connection between space and matter. The particle families may be classified according to single- or double-valuedness of field quantities, according to the type of symmetry with respect to inversions, and according to the order of the field equation. A comparison with the present experimental evidence about elementary particles (rest-mass values, decay schemes, etc.) seems promising. A.

530.145

9408. Fourth order vacuum polarization. G. Källén and A. Sabry. *K. Danske Vidensk. Selsk., mat-fys. Medd.*, **29**, *Paper* 17, 20 *pp.* (1955).

The real and imaginary parts of the kernel are calculated for all values of the four-dimensional energy momentum vector. If an expansion in powers of the square of this quantity is used, the first coefficient agrees with a result previously obtained by Baranger *et al.* A.

530.145

9409. Covariant one-time formulation of the many-body problem in quantum theory. W. Królikowski and J. Rzewuski. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 2, 203–19 (*Aug.*, 1955).

A formulation is obtained by transforming the conventional many-time equations of this problem into other equivalent equations which relate only those values of the wave-function and its derivatives which correspond to one space-like hypersurface σ. The transformation is carried out for arbitrary values of the coupling constant λ with exceptions of certain characteristic values λ_k. For small values of λ explicit expressions are given for the kernels of the one-time equations by means of expansions in powers of λ. These kernels are uniquely determined by the kernels of the original many-time equations. In the absence of external forces the kernels of the one-time equations are independent of the time variable. These equations may be treated, therefore, by means of the stationary perturbation methods in contradistinction to the original many-time equations which do not admit stationary treatment. A.

530.145

9410. Constraints in covariant field theories. II. J. L. Anderson. *Phys. Rev.*, **99**, *No.* 3, 1009–15 (*Aug.* 1, 1955).

For Pt I, see Abstr. 8502 (1951). Analyses the difficulties which occur when one attempts to quantize a theory such as electrodynamics or the general theory of relativity. Because of the invariance properties of theories of this type all of the canonical variables of the theory are not independent of one another but rather there exist certain algebraic relations between them called constraints. These constraints plus the Hamiltonian, in the unquantized version of the theory, constitute a function group. It is proved that there exists at least one ordering of factors in the quantized theory for which this is also true. From this fact it is concluded that it is possible, at least formally, to construct a quantum version of the theories under consideration and that the quantum version will possess the same invariance properties as the corresponding unquantized theory. A.

530.145

9411. On the vertex function in quantized field theory. H. Lehmann, K. Symanzik and W. Zimmermann. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 3, 425–32 (*Sept.*, 1955) In German.

It is shown that the vertex function $\Gamma(p_1, p_2)$ in quantized field theories has to satisfy a condition which implies that it vanishes for large momenta. This condition follows from the requirement that no abnormal states (with negative norm) exist. A.

530.145

9412. A generalization of Vord's [Ward's] theorem to the case of light of finite wavelength [$k^2 = 0$, $k_\mu \neq 0$] for particles with spin 0. I. Pomeranchuk. *Dokl. Akad. Nauk SSSR*, **100**, *No.* 1, 41–2 (1955) In Russian.

See Abstr. 6241 (1950). This is achieved by making a Fourier expansion of the Green's function G_F as

given by Lehmann [Abstr. 5288 (1954)]. In the limit $k_\mu \to 0$ Ward's formula results. W. J. SWIATECKI

530.145

9413. Remarks on non-linear electrodynamics. K. BECHERT. *Ann. Phys.* [*Leipzig*] **16,** *No.* 3–4, 97–110 (1955) In German.

Further development of previous work [Abstr. 35 (1953)]. The unquantized theory leads to an equation for the scalar potential which is closely related to the Poisson equation. An approximate solution of this equation is shown to correspond to a point charge at $r = 0$ and a rotating charge distribution which is concentrated in the region of $r = a$, where a is a length characteristic for the particle under consideration. G. FIELD

530.145

9414. The evaluation of transformation functions by means of the Feynman path integral. W. K. BURTON AND A. H. DE BORDE. *Nuovo Cimento* (*Ser.* 10) **2,** *No.* 2, 197–202 (*Aug.*, 1955).

A parametric representation of the Feynman path integral is used to evaluate the transformation function for some simple systems in particle dynamics. The method is used for systems having equations of motion of the first and second orders. A.

530.145 : 548.7

9415. Radiation theory in crystals. W. KRÓLIKOWSKI. *Acta phys. Polon.*, **14,** *No.* 1–2, 93–105 (1955).

Deals with the radiation theory for the atom in a crystalline medium. In the first part equations are obtained using the formalism of quantum electrodynamics. An apparent mass of the photon appears in that formalism. In the second part the author defines (with certain simplifying assumptions) the formula for the apparent mass of the photon and solves the equations of the radiation field in a crystal. The solution obtained is consistent with Ewald's classical result. In the third part an estimate is given of the emission probability in crystals. A.

530.145

9416. Consequences of gauge invariance for electromagnetic transitions. II. R. H. CAPPS. *Phys. Rev.*, **99,** *No.* 3, 926–31 (*Aug.* 1, 1955).

For Pt I, see Abstr. 4094 (1951). Some theorems developed by Sachs and Austern, regarding the electromagnetic properties of gauge-invariant Schrödinger systems, are generalized so that they may be applied to any gauge-invariant, bound system of particles which is describable by a normalizable state vector. In particular, the following theorems are established: (1) At low photon energy, purely electric radiative or absorptive transitions will depend only on the initial and final state vector of the matter system, and on the energy change (the Siegert theorem). (2) f-sum rules are obtained for electric multipole radiation of arbitrary order, and are expressed in terms of the electromagnetic interactions of the system. (3) If the static moments of the particle system are neglected, the cross-section for γ-ray scattering will depend on the fourth or higher power of the photon energy in the low energy limit. Theorem (3) shows that the energy-independent term in the transition amplitude computed by Sachs and Foldy for the scattering of γ-rays from nucleons, occurs because the nucleon state vector used in their work is not normalizable. A.

530.145

9417. Electromagnetic properties of the nucleon in a finite source theory. R. H. CAPPS AND W. G. HOLLADAY. *Phys. Rev.*, **99,** *No.* 3, 931–43 (*Aug.* 1, 1955).

Some electromagnetic properties of nucleons are investigated under the assumption that the nucleon consists of a spin one-half core particle in interaction with the pion field through a gauge-invariant, non-relativistic, pseudoscalar, finite source interaction. Recoil of the nucleon core is neglected and the weak coupling approximation is used. A method is presented for making the finite source interaction between two particle fields gauge-invariant by introducing filaments of current in the region of the source function. The theoretical contributions of interaction currents to the magnetic moments of the proton and neutron are calculated and found to be small compared to the observed anomalous moments and of the opposite sign. The model is used to calculate, in the limit of zero source size, the total and differential cross-sections for scattering of γ-rays from nucleons. The results, which are presented graphically, are found to be in accord with the conditions imposed on a finite theory in the preceding paper (preceding abstract). They are compared to the results obtained by Sachs and Foldy on the basis of a point-source theory. A.

530.145

9418. Spherical spinors in a Euclidean 4-space. A. PAIS. *Proc. Nat. Acad. Sci. U.S.A.*, **40,** *No.* 9, 835–41 (*Sept.*, 1954).

A note explicitly constructing the spinors used in a model [Abstr. 9939 (1954)] to describe baryon states.

530.145

9419. Remarks on the theories of Pais and Gell-Mann. B. D'ESPAGNAT AND J. PRENTKI. *C.R. Acad. Sci* [*Paris*] **240,** *No.* 26, 2486–8 (*June* 27, 1955) In French.

Modifications are suggested of the elementary particle theory of Pais (preceding abstract) to give the states and charges of the Gell-Mann model. P. T. MATTHEWS

530.145

9420. On the relation between the theory of Tomonaga–Schwinger and that of Dirac–Fock–Podolsky. P. BOCCHIERI AND A. LOINGER. *Nuovo Cimento* (*Ser.* 10) **2,** *No.* 2, 314–19 (*Aug.*, 1955) In Italian.

A covariant generalization of a method due to Becker and Leibfried is demonstrated. It is shown that, for identical particles, the many-time theory, as formulated by Dirac–Fock–Podolsky, is equivalent to a non-physical formulation of the field theory of Tomonaga–Schwinger, concerning a finite number of particles. A.

530.145

9421. An analogy between the quantum electrodynamics and classical electrodynamics of the corpuscular description. A. LOINGER. *Nuovo Cimento* (*Ser.* 10) **2,** *No.* 3, 511–18 (*Sept.*, 1955) In Italian.

It is shown that for a non-relativistic point-electron

the position operator of the particle satisfies an equation that is formally analogous to the classical Dirac–Lorentz equation. A.

530.145

9422. Isotopic spin and the group space of the proper Lorentz group. E. J. SCHREMP. *Phys. Rev.*, **99**, *No.* 5, 1603 (*Sept.* 1, 1955).

By a slight modification of the algebraic foundations of spin-$\frac{1}{2}$ theory, isotopic spin is incorporated therein, in a natural and irreducible manner. The method of approach proceeds from a consideration of the geometry of the group-space of the proper Lorentz group. A.

530.145

9423. On a bilocal theory of families of elementary particles. J. RAYSKI. *Acta phys. Polon.*, **14**, *No.* 1–2, 107–20 (1955).

The generalized bilocal wave equations restricted by reciprocally invariant supplementary conditions describe families of particles with various spin and mass values. In contradistinction to a previous supposition no direct connection with the isotopic spin theory exists. A close connection with Fierz's theory of higher spins is shown. The question of interaction is briefly discussed. A.

530.145

9424. Lectures on pions and nucleons. E. FERMI. *Nuovo Cimento Suppl.* (*Ser.* 10) **2**, *No.* 1, 17–95 (1955).

Meson-nucleon scattering is analysed in terms of isotopic spin and phase shifts. Photoproduction is related to meson-nucleon scattering through gauge invariance, and the p^0 and n^+ cross-sections to the scattering phase-shifts through the general properties of the S-matrix. Meson production by nucleon-nucleon collisions is discussed in terms of isotopic spin, with particular reference to the possibility of deuteron formation. The theory and practice of double scattering experiments with polarized nucleon beams is described. P. T. MATTHEWS

530.145

9425. Spin-orbit coupling in the pseudoscalar meson theory of nuclear forces. G. ARAKI. *Progr. theor. Phys.*, **13**, *No.* 1, 13–18 (*Jan.*, 1955).

Fourth-order nuclear forces were derived by Sato on the basis of the pseudoscalar meson theory. The spin-orbit coupling contained in his result is examined in the approximate way. The doublet interval $^2D_{3/2} - {}^2D_{5/2}$ of the O^{17} nucleus due to this spin-orbit coupling is calculated taking into account all spin-orbit couplings between seventeen nucleons according to the method of Talmi. The result contains a divergent integral. If it is made to converge by a suitable device, the interval value is nearly 5 MeV (the observed value is 5·08 MeV). The theoretical result on the same assumption is too large compared with experiment in case of He^5 and Li^5. A.

530.145

9426. On the universality of the weak Boson–Fermion interaction. K. IWATA, S. OGAWA, H. OKONOGI, B. SAKITA AND S. ONEDA. *Progr. theor. Phys.*, **13**, *No.* 1, 19–37 (*Jan.*, 1955).

For shorter preliminary account, see Abstr. 58 (1955). With the aim of investigating the possibility of reducing the complicated interactions between various sorts of elementary particles to some kind of interactions which have certain primary and universal character, analysis is made of the weak interactions between Bosons and Fermions which appear in the recent high-energy experiments. It is suggested that there might exist one type of interaction which seems to have the desired property. That is, when a weak interaction of the type $g\bar{\psi}_a\gamma_5\gamma_\mu\psi_b\partial_\mu\phi_c$ or $g\bar{\psi}_a\gamma_\mu\psi_b\partial_\mu\phi_c$ is set up between any pair of spinor fields ψ_a, ψ_b (spin $\frac{1}{2}$) and any Boson field ϕ_c (spin 0), nearly unique value of the coupling constant g seems to be consistent with so many remarkable reactions. Assuming the universal character of this interaction, the consistency of the coexistence of this interaction with other similar ones such as universal Fermi interaction, etc., is discussed and the possible reasons for the necessity of its introduction. In this connection the problem whether the newly found spinor fields (Λ-particle and possibly κ-meson) may be included in the universal Fermi interaction scheme consistently is briefly examined. As an example of the selection principles which forbid unwanted processes, the conservation law of the Fermion numbers is taken, to test its workability. A.

530.145

9427. Intermediate coupling meson theory of nuclear forces. I. General formulation. H. HASEGAWA. *Progr. theor. Phys.*, **13**, *No.* 1, 47–61 (*Jan.*, 1955).

The method of construction of nuclear potential is represented in charged scalar meson theory as example, assuming that (i) the kinetic energies of the nucleons are not very large, and (ii) interaction between nucleons and meson field is not very strong. Starting with the single clothed nucleons, we restrict the number of mesons exchanged between the nucleons up to two. This corresponds to the expansion of the nuclear potential into the power of $\exp(-\mu r)$. The assumption (i) guarantees this procedure. The potential of order of $\exp(-\mu r)$ differs from the conventional one by the factor $(1 - P_d)^2$ which is due to the dissociation probability P_d of the single clothed nucleon. The potential of order of $\exp(-2\mu r)$ originates from the effects: (i) distortion of zero-meson fields, (ii) transition to the isobaric states, (iii) emission and absorption of s-mesons by the individual particles. The exchange of the s-meson cannot occur, so far as the potentials up to the order of $\exp(-2\mu r)$ are concerned. This suggests that the zero-mesons described by intermediate coupling meson theory would give a good picture of the meson cloud around the nucleons, for low-energy nuclear forces. A.

530.145

9428. Derivation of the value of the coupling constant g from the rest energy of the nucleon. F. CAP. *Progr. theor. Phys.*, **13**, *No.* 1, 62–8 (*Jan.*, 1955).

The static interaction energy between two nucleons and the value of the coupling constant g are derived from a unitary nonlinear charge-symmetrical pseudo-scalar meson theory that contains no free parameters. A.

530.145

9429. The properties of the meson theoretical potentials in Li^6. S. OTSUKI, T. SAWADA AND S. SUEKANE. *Progr. theor. Phys.*, **13**, *No.* 1, 79–92 (*Jan.*, 1955).

To study the properties of the symmetrical pseudo-

scalar meson theoretical potentials in nuclei, the authors apply them to Li^6, which is expected to disclose the properties of two-body forces in nuclei as directly as possible, and investigate how favourable these potentials are to the static properties of Li^6. The potentials between two nucleons are divided into two regions at 0·6 times the meson Compton wavelength. The outside potentials are derived from symmetrical pseudoscalar meson theory, while the inside potentials are determined from nucleon-nucleon scattering experiments phenomenologically. The excitation energies of the levels and the nuclear moments are calculated according to the intermediate coupling method. The meson theoretical potentials are very favourable to Li^6 without any modification, though the contribution from the potentials of the inside region is large. The order and spacing of the levels and spins are reproduced correctly up to the 3rd excited state. The corresponding spin-orbit coupling strength is large ($-8 \sim -12$ MeV), and can also explain the nuclear moments in the same region, so it is closer to the *jj*-coupling limit than to the *LS*-coupling limit. The tensor force does not affect the results essentially. A.

530.145

9430. Note on the Tamm–Dancoff method. E. Arnous. *Proc. Roy. Irish Acad. A*, **57**, *No.* 3, 31–6 (*Feb.*, 1955).

The Tamm–Dancoff method leads for the stationary states and for the scattering matrix of quantized fields to formulae which can be written in closed form. They contain a "potential," which satisfies an integral equation. This may be solved without expansion according to the coupling constant, for instance, with the help of a "trial potential." See also abstract following. A.

530.145

9431. On the Tamm–Dancoff method. E. Arnous. *C.R. Acad. Sci.* [*Paris*] **241**, *No.* 3, 281–3 (*July* 18, 1955) In French.

See preceding abstract. The formula $V = H^- [-H_0 - (V - \nu)]^{-1} H^+$ is derived for the potential V, where H_0 is the unperturbed Hamiltonian, H^+ and H^- the creation and annihilation parts of the interaction Hamiltonian H, and ν is the vacuum expectation value of V. It can be applied to expansion in the coupling constant as well as to trial solution methods. G. FIELD

530.145

9432. The anomalous magnetic moments of nucleons. Yu Min. *Scientia Sinica*, **4**, *No.* 1, 95–105 (*March*, 1955).

The nucleon magnetic moments and the neutron-electron interaction potential have been calculated by using the theory of pseudo-scalar mesons with pseudo-vector coupling. The divergence in the neutron-electron interaction is removed after the vacuum polarization effect due to virtual mesons has been taken into account. The final result is the same as in the case of pseudo-scalar mesons with pseudo-scalar coupling. A.

530.145

9433. Baryon meson system in Pais formalism: the scattering matrix. S. P. Misra. *Indian J. Phys.*, **29**, *No.* 5, 243–53 (*May*, 1955).

An explicit formulation of the scattering matrix in a formalism introduced by Pais is given. Only the baryon meson system is considered, starting from an equation similar to Tomonaga's equation. Some selection rules for different processes or Feynman graphs are obtained. A.

530.145

9434. On the Yang–Feldman formalism. S. S. Schweber. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 3, 397–412 (*Sept.*, 1955).

The connection between the in- and out-fields and the interaction representation fields is established. The commutation rules for these as well as the symmetric field are obtained. The formulation of scattering theory in terms of these fields is rederived from their connection with the interaction representation. A.

530.145

9435. A field theoretical model for *S*-wave pion-nucleon scattering. B. Bosco and R. Stroffolini. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 3, 433–42 (*Sept.*, 1955).

A field theoretical model is discussed which can be solved exactly. This model corresponds to a *ps-ps* Hamiltonian, in which only those terms are retained which correspond to the creation of one nucleon-antinucleon pair and to the destruction of one meson together with the inverse process. With this reduced Hamiltonian a finite number of particles are present also in the virtual state. For the pion-nucleon scattering only a single pair can exist in the intermediate states, and the low energy *s*-wave phase-shifts are evaluated. The agreement with experiment is good. A.

530.145

9436. Relativistic corrections for high-energy *p-p* scattering. G. Breit. *Phys. Rev.*, **99**, *No.* 5, 1581–96 (*Sept.* 1, 1955).

It is shown that the treatment of the collision of two charged particles by means of a first-order Born approximation and Møller's matrix element involves an inconsistency connected with the infinite cross-section for small-angle scattering. It is then shown that an energy formula derived for the two-body interaction by means of an early form of the Heisenberg–Pauli quantum electrodynamics makes it possible to construct a relativistic two-body extension of the nonrelativistic one-body Mott–Gordon solution. This extension is good only to order e^2 but arguments are given for believing that the angle-dependent and e^2-containing factors are partially correct for the more important terms. The Gordon sphere construction naturally leads to such factors and the consideration of small-angle collisions in the laboratory system leads to a similar result. The latter suggests the possible existence of correction terms. The explicit superposition of partial waves is avoided by noting a formal similarity of the relativistic and nonrelativistic problems for principal non-spin-dependent terms. Contributions of the spin-dependent terms are worked out, also avoiding explicit summation by employing a momentum space representation and noting that once the main terms are taken care of by the Gordon sphere construction, the spin-dependent terms can be

treated as a perturbation on account of their more rapid fall-off with distance. The possibility of dealing with first-order phase shifts by means of a phase-shift matrix, the coupling of states with different L but the same J, and the definition of phase shifts in the relativistic problem, neglecting meson production, are discussed. A.

530.145

9437. Phase shifts for relativistic corrections in high-energy *p-p* scattering. M. E. Ebel and M. H. Hull, Jr. *Phys. Rev.*, **99**, *No.* 5, 1596–9 (*Sept.* 1, 1955).

Scattering phase shifts for the relativistic corrections to the ordinary Coulomb interaction between two protons are calculated in the first Born approximation. The scattering matrix resulting from these phase shifts is obtained and shown to agree with the results of the preceding abstract. A.

530.145

9438. Electromagnetic properties of the deuteron. M. Sugawara. *Phys. Rev.*, **99**, *No.* 5, 1601–2 (*Sept.* 1, 1955).

Exchange current corrections to the deuteron magnetic and quadrupole moments have been calculated, assuming *ps–ps* theory, employing Tamm–Dancoff formalism, and retaining only up to one-meson amplitudes. The numerical values were estimated by using some reasonable deuteron wave functions. It is shown that the $S - D$ cross term is the dominant term and the effect of the change of normalization is always very big, making the whole correction to the deuteron magnetic moment always negative. The relativistic and the nonadditivity corrections to the deuteron moments have also been estimated under the same approximation. The over-all correction to the magnetic moment is shown to be negative and the final estimate of the deuteron D-state probability is $3 \pm 1\%$. A.

530.145

9439. On the meaning of relativistic wave functions. E. C. G. Stueckelberg and G. Wanders. *Helv. phys. Acta.*, **28**, *No.* 4, 352–5 (1955) In German.

Asymptotic expressions for relativistic wave-functions (matrix-elements of T-products of Heisenberg operators) are given. G. E. BROWN

530.145

9440. Matrix elements between states in the Coulomb field. K. Alder and A. Winther. *K. Danske Vidensk. Selsk., mat-fys. Medd.*, **29**, *Paper* 18, 17 *pp.* (1955).

It is shown that the matrix elements between radial eigensolutions in a Coulomb field of functions of the type $r^p \exp(-qr)$ can be expressed explicitly by means of hypergeometric functions of two variables. The calculation is made separately for the non-relativistic and relativistic case. Recursion formulae connecting the matrix elements are discussed and specializations to discrete-discrete, discrete-continuous and continuous-continuous transitions are given. A.

530.145

9441. Well-behaved wave functions and wave functions with a singular region in wave mechanics. L. de Broglie. *C.R. Acad. Sci.* [*Paris*] **241**, *No.* 4, 345–8 (*July* 25, 1955) In French.

Generalizing a previous method [Abstr. 1550 (1955)] a derivation of the theorem of the "guided wave" in the theory of the double solution is indicated which stems solely from an eqn. of continuity. The importance of this concept for a possible reinterpretation of wave mechanics is discussed. F. ANSBACHER

530.145

9442. Wave equation for spin 0 in Hamiltonian form. K. M. Case. *Phys. Rev.*, **99**, *No.* 5, 1572–3 (*Sept.* 1, 1955).

It is shown that the Hamiltonian form for spin 1 particles also describes spin 0 particles if the 5-dimensional representation of the Duffin–Kemmer algebra is used. A.

530.145

9443. Necessary condition for positive definite energy. R. L. Pease and J. Pease. *Phys. Rev.*, **99**, *No.* 5, 1600–1 (*Sept.* 1, 1955).

A necessary condition for positive definite energy density of the plane-wave components of a system described by a linear first-order wave equation is expressed as a condition on the wave-equation matrices alone. Hence the condition for positive-definite total energy of a system may be applied without the need for extracting the Hermitizing operator. The criterion is applied to a system discussed by Bhabha. A.

530.162

9444. The formalism of second quantization in quantum statistical mechanics. R. Gatto. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 3, 592–604 (*Sept.*, 1955).

The advantage is pointed out of using an invariant formulation of quantum statistical mechanics with respect to unitary transformations of the Hilbert space. Second quantization allows one to give an invariant formulation of the quantum mechanical grand ensemble. It provides a simpler framework for the use of transformation theory, and perturbation theory can be developed most conveniently in a way independent from the representation. The summations over the virtual intermediate states are, in a certain sense, absorbed into the c-numbers which arise by the commutations, a formal procedure which is largely used in quantum electrodynamics. The method is applied to a field-theoretical example, and some thermodynamical points are discussed. A.

530.162

9445. On the form and content of the diffusion equation. J. A. Christiansen. *Z. Elektrochem.*, **59**, *No.* 5, 338–40 (1955) In German.

In deriving the diffusion equation (with or without external field) the change in kinetic energy, corresponding to the average velocity in the direction of diffusion, must be taken into account. Then, minimizing the total energy, the diffusion equation can be obtained in a form identical with Schrödinger's equation in agreement with Fényes [Abstr. 5523 (1952)], where the diffusion coeff. replaces $h/4\pi m$. F. ANSBACHER

530.162

9446. Numerical solution of equations of the diffusion type with diffusivity concentration-dependent. J. R. Philip. *Trans Faraday Soc.*, **51**, *Pt* 7, 885–92 (*July*, 1955).

A new iterative procedure is given for the numerical solution of the equation

$$\frac{\partial \theta}{\partial t} = \frac{\partial}{\partial x}\left(D\frac{\partial \theta}{\partial x}\right)$$

in the semi-infinite solid with simple conditions. With D a single-valued function of θ and the conditions $\theta = \theta_n$, $t = 0$, $x > 0$, $\theta = \theta_0$, $x = 0$, $t \geqslant 0$. Unlike the method previously available, this procedure converges rapidly and each iterative step is simple. The solution as $\theta \to \theta_n$ is $x \to \infty$, the inelegant truncation heretofore required proving unnecessary. The function $A(x) = 2x$ ierfc x/erfc x occurs in the course of the analysis. This function is investigated very briefly and a short table of $A(x)$ is given. The errors of the method due to incomplete convergence and truncation are studied empirically. An appendix gives an extension of Neumann's solution (for D a two-step function of θ) when D is an n-step function of θ. Formal solution reduces to the problem of solving $(3n - 1)$ simultaneous equations, so that the numerical method of the paper will generally prove much simpler. A.

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531.225

9447. Torque condition for equilibrium. W. T. Scott. *Amer. J. Phys.*, **23**, *No.* 7, 407–9 (*Oct.*, 1955).

The torque condition for equilibrium can be derived from Newton's first and third laws, the postulate of central forces, and some geometrical considerations. Such a derivation, or adequate statements about its possibility, were not found in 52 elementary textbooks examined. A simple form of this derivation is given. A.

531.32

9448. Note on the study of simple harmonic motion. H. S. C. Chen. *Amer. J. Phys.*, **23**, *No.* 7, 467–8 (*Oct.*, 1955).

A new approach to the study of simple harmonic motion is presented. A record is taken of the positions at different times by means of a spark timer. From the limits approached by the average velocities, instantaneous velocities are obtained. From the limits approached by the average accelerations, instantaneous accelerations are obtained. A linear relation shows the direct proportionality between acceleration and displacement. The period of SHM may be determined from the slope of this straight line and compared with the experimental value. A.

531.57

9449. Method for producing high-velocity metallic and plastic pellets. M. E. Van Valkenburg and C. D. Hendricks, Jr. Letter in *J. appl. Phys.*, **26**, *No.* 6, 776–7 (*June*, 1955).

Allen, Rinehart and White [Abstr. 2439 (1952)] have accelerated metallic pellets to velocities of 2–6 km/sec by projecting them from the end of a detonating cylinder of explosive. This method suffers from the disadvantage that the pellets are frequently broken into small fragments; to overcome this difficulty the present authors have interposed an inert layer (of oil or cast polyester resin) between the explosive and the pellet. An additional advantage of the modified technique is that the pellet velocity can be controlled by varying the thickness of the inert layer. A. SCHOFIELD

MECHANICAL MEASUREMENTS 531.7

531.717.1

9450. Tube wall thickness gauge with selection of backscattered γ-radiations. J. L. Putman, S. Jefferson, J. F. Cameron, J. P. Kerry and E. W. Pulsford. *J. sci. Instrum.*, **32**, *No.* 10, 394–8 (*Oct.*, 1955).

A gauge is described in which γ-rays scattered back from a thickness of metal are distinguished from primary γ-rays by virtue of their reduced energy. The selection is achieved by using a scintillation counter with a sodium iodide phosphor as detector, followed by a single channel kicksorter as energy selector. The need for screening is thus eliminated and the source and detector can be mounted close together. This results in a light-weight measuring head, capable of very local measurement of thickness. The electronic circuit is arranged to permit single compensation for source decay so that constant calibration is preserved when using a Co^{60} source. The instrument is suitable for measuring the tube wall or plate thicknesses up to $\frac{7}{8}$ in. of steel and is particularly useful in detecting corrosion pitting in tubes. A.

531.717.31

9451. An instrument for the measurement of relief heights. W. J. Stallan. *Royal Photographic Society International Conference* [*London*] 305–8. See Abstr. 7586 (1955).

An instrument is described which was designed to measure mechanically the differences in relief height of photographic matrices, with a sensitivity of 0·000 002 in. The paper includes a brief survey of the development of the instrument, a general description of it, and some examples of the results obtained. A.

531.743

9452. Deflection multiplier for reflecting galvanometers. T. M. Dauphinee. *Rev. sci. Instrum.*, **26**, *No.* 9, 873–5 (*Sept.*, 1955).

A very simple multiple reflection system is described by which the effective sensitivity of a reflecting galvanometer can be increased by a factor of five or more without increasing the mirror-to-scale distance. The full width of the galvanometer mirror is used for each reflection, so that with a good quality mirror there is little reduction in the sharpness of the hairline image and only moderate reduction in the brightness of the spot. Use of a 2 m path distance and four or five reflections makes it possible to extend the useful sensitivity of a sensitive galvanometer close to the limit set by Brownian movement. The principle of this amplifying system can be applied directly to most forms of optical lever. A.

531.787.3

9453. Piston-type strain gauge for measuring pressures in interior ballistics research. J. Dimeff, J. A. Carson and A. C. Charters. *Rev. sci. Instrum.*, **26**, *No.* 9, 879–83 (*Sept.*, 1955).

Various types of pressure gauges used in interior ballistics research are discussed briefly. A piston-type strain gauge suitable for measuring the time history of transient pressures with components from

steady state to 50 kc/s and magnitudes to 2×10^5 lb/in.^{2}, is described in detail. A.

MECHANICS OF FLUIDS 532

532.137

9454. Calculation of the shear stress for the falling sphere viscometer. J. SCHURZ. Letter in *Naturwissenschaften*, **42**, *No.* 11, 339–40 (1955) In German.

Formulae for the mean and max. shear stress are discussed. J. E. CAFFYN

532.51 : 533.7

9455. On some problems in free molecule–slip flow regimes. M. Z. v. KRZYWOBLOCKI. *Acta. phys. Austriaca*, **9**, *No.* 3–4, 216–57 (1955).

In the first part the author discusses the fundamental equations of hydrodynamics and their limitations. Next, the procedure of Epstein, valid in the domain of small macroscopic velocities of motion, is generalized to any Mach number. In the domain of free molecule flow with intermolecular collisions, a new approximation solution is proposed. In the last part, the bordering domain of slip-free molecule flow is considered and new slip boundary conditions are derived. A.

532.517

9456. The drag on a circular cylinder moving with low speeds in a viscous liquid between two parallel walls. Y. TAKAISI. *J. Phys. Soc. Japan*, **10**, *No.* 8, 685–93 (*Aug.*, 1955).

The steady slow motion of a circular cylinder in a viscous liquid bounded by two parallel plane walls is discussed on the basis of Oseen's linearized equations of motion, considering only the case when the cylinder is moving midway between the bounding walls. The drag experienced by the cylinder is then calculated to Lamb's approximation. It is shown that at sufficiently small Reynolds numbers, the drag on the cylinder is independent of the Reynolds number, namely, it is of the so-called Stokes type, as was shown by White's experiments on wires falling in viscous liquids between two vertical plates. When the ratio of the distance between the walls to the diameter of the cylinder is greater than 20, the present theoretical results coincide fairly well with White's experiments, allowing for some experimental errors. A.

532.517

9457. The critical Reynolds number for the flow past a sphere. M. KAWAGUTI. *J. Phys. Soc. Japan*, **10**, *No.* 8, 694–9 (*Aug.*, 1955).

The stability of the flow past a sphere, which has been calculated previously by use of the Galerkin method, was investigated by the method of small perturbation and the Galerkin method. Thus the critical Reynolds number for the flow past a sphere was determined as 51, which should be compared with the experimental value of about 100. A.

532.528

9458. An experiment for the demonstration of cavitation bubbles and cavitation nuclei. W. GÜTH. *Acustica*, **5**, *No.* 3, 192–5 (1955) In German.

A simple apparatus for projecting the outlines of cavitation bubbles 100-fold for demonstration to a large audience is described. The bubbles are formed on a steel diaphragm excited by a pressure pulse. Shortly after the excitation, the cavitation bubbles are illuminated by a high-voltage spark and so projected. Before they grow there appear, under the influence of the negative pressure set up by the pulse, many small bubbles on the cavitation nuclei existing in the water. A.

532.574

9459. How radiotracers are used in measuring fluid-velocity profiles. F. M. RICHARDSON, J. K. FERRELL, H. A. LAMONDS AND K. O. BEATTY, JR. *Nucleonics*, **13**, *No.* 7, 21–3 (*July*, 1955).

The lower part of a vertical tube is filled initially with a tracer solution, while the upper part contains tracer-free solution. When flow starts the profile of the separating surface is related to the velocity profile across the tube. The former is determined by measuring the radiation received in a suitable detector situated at a point downstream from the initial surface of separation. Na^{24} in aqueous Na_2CO_3 solution was used as a tracer with a scintillation detector to measure the γ-radiation received from a defined section of the tube. L. R. SHEPHERD

CAPILLARITY 532.6

532.612 : 532.614 : 536.7

9460. Thermodynamics and statistics of boundary surfaces. K. SCHÄFER. *Z. Elektrochem.*, **59**, *No.* 4, 237–49 (1955) In German.

Owing to the difference in binding of a molecule inside and on the surface of a liquid the enthalpy and Gibbs free energy of a liquid are different for the interior and the surface. Surface- and boundary-surface tensions, capillary pressure, and equilibrium form of the boundary surface, which are consequences of this, are derived and discussed for some special cases. The relation between surface tension and temperature is derived by a thermodynamical-statistical method, giving Eötvös' rule. The influence of solutes and of surface charges are described by the Gibbs and Lippmann–Helmholtz eqns. The change of surface tension due to dissolved electrolytes (and their concentration distribution) is calculated and compared with some measurements. The behaviour of capillary active substances is briefly discussed. F. ANSBACHER

532.612.4

9461. Studies on surface effects with capillary-inactive aqueous solutions. K. SCHÄFER, A. PEREZ MASIÀ AND H. JÜNTGEN. *Z. Elektrochem.*, **59**, *No.* 5, 427–36 (1955) In German.

The surface tension of aqueous solutions of alkali halides and of HCl has been measured at 20°C over the range 0·01 to 0·3 N, using a stretched wire method. A precision of 0·001% is claimed. Except for HCl and NaF the results agree satisfactorily with those calculated from a theory based on statistical thermodynamics, and postulating a degree of ionic hydration which increases with increasing distance from the surface. The deviations of HCl and NaF from the theory are briefly discussed. S. J. GREGG

532.65

9462. On the adhesion of drops and particles on impact at solid surfaces. I. T. GILLESPIE. *J. Colloid Sci.*, **10**, *No.* 3, 266–80 (*June*, 1955).

The deposition of particles on the surface of a thin cylinder exposed to a low-velocity aerosol stream has been studied. The experimental results may be interpreted by rejecting the common assumption that aerosol particles always adhere to surfaces on contact. The presence of electric charges on some of the aerosol particles enhances their chances of adhering to a surface. Coating of a cylinder may affect the chances of specific aerosol particles adhering to it. Many of the discrepancies between the actual performance of filters and that which would be expected from theory may be rationally explained by taking into account the possibility that not all the particles or drops which graze the surface of the fibres adhere. Non-adherence on impact would appear to be limited to a range of particle or drop velocity and to depend upon the physical properties of the drop or particle as well as the collecting surface. A.

532.65

9463. On the adhesion of drops and particles on impact at solid surfaces. II. T. GILLESPIE AND E. K. RIDEAL. *J. Colloid Sci.*, **10**, *No.* 3, 281–98 (*June*, 1955)

The results of a study of the oblique impaction of aerosol drops on to a solid surface may be interpreted on the hypothesis that there is a range of velocities of impact in which adhesion on contact is not certain and that the drops leave the surface at or near the point of impact. A high-speed photographic study of the oblique impact of large drops on to a solid surface has revealed that there is an elastic reaction on impact and (1) the area of contact depends upon the velocity of impact and the drop size; (2) when a drop strikes a surface, the area of contact might be relatively small for a considerable time; and (3) the real area of contact might be very small, presumably owing to air trapped between the liquid and solid. Using Hertz's theory of elastic impact and introducing a qualitative correction for the possibility that the real area of contact may be less than the apparent led to a deeper understanding of the experimental expression previously presented for the lack of adhesion of aerosol drops and particles in filtration and other experiments. The lack of adhesion is attributed to the air drag which acts throughout the contact process and aided by the tendency to bounce removes drops by a necking out process and particles by a peeling action. At low velocities the air drag is not large enough to detach drops and particles on impact, and at large velocities the real area of contact is large enough to ensure adhesion. This accounts for there being a range of velocities in which adhesion on contact is not certain, whereas adhesion occurs above and below this range. A.

532.696.1 : 539.172.4

9464. The significance of wetting in reactor technology. J. W. TAYLOR. *J. nuclear Energy*, **2**, *No.* 1, 15–30 (*Aug.*, 1955).

The fundamental forces responsible for the spreading of a liquid metal on a solid (or a liquid) surface are discussed, and a number of interfacial tension and spreading studies are analysed in terms of the theoretical considerations. In the light of these, methods of modifying the interfacial tension in any given application are suggested. The significance of interfacial effects in the following technological processes is outlined: (i) liquid metal corrosion and intergranular penetration; (ii) heat transfer; (iii) mass transfer and zone melting; (iv) liquid metal slurry properties and stability; (v) extraction metallurgy. A.

MOLECULAR THEORY OF LIQUIDS 532.7

532.7

9465. Quantum properties of the condensed state. J. DE BOER. *Proceedings of the International Conference of Theoretical Physics* [*Tokyo*] 507–30 (1954). See Abstr. 9391 (1955).

A survey is given of the different methods which are available for the quantum statistical treatment of a condensed system, i.e. the treatment of an ideal gas, the series expansion in powers of the density for a system of interacting molecules and the cell method for the case of high densities. The single-cell method is generalized to the cell-cluster method and an attempt is made to explain on this basis some of the properties of the thermal excitation of liquid helium. A.

532.7

9466. A cell-cluster theory for the liquid state. II. E. G. D. COHEN, J. DE BOER AND Z. W. SALZBURG. *Physica*, **21**, *No.* 3, 137–47 (*March*, 1955).

The cell-cluster theory for the liquid state developed in a previous paper (preceding abstract) has been completed by evaluating the combinatorial factor which is involved. In the 1-dimensional case this combination factor can be given in exact form. In the 2- and 3-dimensional case approximate solutions are obtained for this combinatorial problem, using a method similar to that introduced by Kikuchi. As an example the formulae are applied to the ideal gas case. This leads to a complete appearance of the "communal entropy" in the 1-dimensional case. In the 2- and 3-dimensional cases the first correction accounts already for a large part of this "communal entropy." A.

532.7 : 532.13

9467. On the application of the kinetic theory of liquids of Born and Green to the problem of the calculation of the volume viscosity. R. E. NETTLETON. *J. chem. Phys.*, **23**, *No.* 8, 1560 (*Aug.*, 1955).

A method has been tried for estimating the effect of collisional transfer on the bulk viscosity; the effect of triple collisions being neglected. T. C. TOYE

532.7 : 536.7

9468. Thermodynamic properties of the system methane-carbon monoxide at 90·67°K. V. MATHOT, L. A. K. STAVELEY, J. A. YOUNG AND N. G. PARSONAGE. Letter in *J. chem. Phys.*, **23**, *No.* 8, 1551 (*Aug.*, 1955).

A positive excess free energy and a volume contraction on mixing are found in agreement with the cell theory. C. TURNER

532.71

9469. Influence of permeable membranes on the measured values of osmotic pressures. T. A. BARR. *Amer. J. Phys.*, **23**, *No.* 7, 436–9 (*Oct.*, 1955).

An "operational" definition of osmotic pressure is presented and the difference between this definition and the thermodynamic definition of osmotic pressure is pointed out. By the use of a negative pressure osmometer a formula is developed to express the values of "osmotic pressures" when the osmometer membrane is permeable to both solvent and solute. A membrane factor B is introduced to account for the efflux of solute from the osmometer. B is evaluated in terms of the effective solute diffusion coefficient, D. A.

532.72

9470. Some measurements of diffusion in liquids. P. CHANG AND C. R. WILKE. *J. phys. Chem.*, **59**, *No.* 7, 592–600 (*July*, 1955).

Diffusion coefficients for iodine and toluene in a series of saturated hydrocarbons and for benzoic, acetic and formic acids in a number of organic solvents are reported. Data were obtained by the diaphragm cell method. A.

532.72

9471. The measurement of self-diffusion in electrolyte solutions. R. MILLS AND A. W. ADAMSON. *J. Amer. Chem. Soc.*, **77**, *No.* 13, 3454–8 (*July* 5, 1955).

A study has been made of the sources of the discrepancies between values for the self-diffusion coefficients of ions in aqueous solutions as determined by various methods. Calibration of open-ended capillaries by comparing measured values with known differential diffusion data, has shown that the former values tend to be high, the effect being attributable in part to losses by mechanical convection. By direct calibration in dilute and concentrated solutions, it has also been shown that the value of the cell constant for a diaphragm cell does not change (within experimental error) over a concentration range. New measurements of the self-diffusion coefficients of sodium ion in sodium chloride solutions, with diaphragm cells calibrated in this manner, give values which agree with previous open-ended capillary measurements in concentrated solutions and approach them more closely in dilute solutions. A.

532.72

9472. Self-diffusion in liquid indium and tin. G. CARERI AND A. PAOLETTI. *Nuovo Cimento* (*Ser.* 10), **2**, *No.* 3, 574–91 (*Sept.*, 1955).

Self-diffusion measurements have been made on liquid indium and tin over a wide range of temperatures, and a small but systematic deviation from the ordinary Arrhenius equation has been detected. After the customary discussion of the Stokes–Einstein and Eyring equations, new expressions are worked out in the quasi crystalline picture of the liquid state following the solid state treatment of the diffusion processes. It is then shown how the deviations from the Arrhenius equation are accounted for by a direct interchange mechanism of nearest neighbours, due to a ring movement of two atoms. A.

532.77 : 532.612.4

9473. On the theory of surface tension of solutions. Remarks on the relation between radial distribution function and the thermodynamic functions. E. SCHMUTZER. *Z. phys. Chem.* [*Leipzig*] **204**, *No.* 1–2, 131–56 (*Feb.*, 1955) In German.

Starting with the two equations of state

$$p = \eta kT - \frac{2\pi}{3}\frac{N(N-1)}{V^2}\int_0^\infty \frac{\partial\phi}{\partial r} r^3 g(r)\,dr$$

and

$$\frac{u}{\eta kT} = \frac{3}{2} + \frac{2\pi N}{VkT}\int_0^\infty r^2\phi(r)g(r)\,dr$$

equations for the free energy, entropy and chemical potential in terms of the radial distribution function are straight away derived. Using this information with the Gibbs' adsorption equation an expression for surface tension is then derived both for electrolytes and also for solutions in general. The theory is applied to the special case of an aqueous solution of NaCl, the agreement with experiment being good; while the temperature-dependence is also in accord with the theory. The authors think that the theory will also apply to liquid mixtures provided of course that the various necessary assumptions still hold true. T. C. TOYE

MECHANICS OF GASES 533

533.07 : 537.534.3

9474. A gas handling system suitable for use with a mass spectrometer. G. H. PALMER. *Atomic Energy Res. Establ.* [*Harwell*] *Mem. G/M*50, 2 *pp.* (1950).

The gas handling system is made of glass, and the gas is controlled with mercury cut-off valves. A very simple glass leak is described which connects the glass system to a spectrometer. A.

533.15

9475. The separation tube. XV. The reversal effect of thermal diffusion in mixtures of the neon isotopes with normal and deuterium ammonia. K. CLUSIUS AND M. HUBER. *Z. Naturforsch.*, **10a**, *No.* 7, 556–65 (1955) In German.

For Pt XIV, see Abstr. 6800 (1955). The absolute values of the thermal diffusion factor α have been determined with the "swing separator" (see Pt XIV) for the above mixtures. In a separation tube the dependence of the separation factor on the pressure and the mixture ratio has been measured. The earlier objections raised against the authenticity of the reversal effect are shown to be incorrect. In the Ne^{20}/NH_3 system the change of sign of α occurs at 75% Ne^{20}, in the Ne^{22}/NH_3 system at 42% Ne^{22}, and in the Ne^{20}/ND_3 all the α values are negative. The mixture dependence of α for all three gas pairs is satisfactorily described by Chapman's theory of thermal diffusion and the Kihara approximation for molecules with a Lennard–Jones (6, 12) potential. A series of further conclusions are discussed. H. C. COLE

533.15

9476. Second approximation to the thermal diffusion factor on the Lennard–Jones 12 : 6 model. S. C. Saxena and B. N. Srivastava. *J. chem. Phys.*, **23**, *No.* 9, 1571–4 (*Sept.*, 1955).

Several collision integrals useful for the calculation of the second approximation to the thermal diffusion factor have been evaluated for the Lennard–Jones 12 : 6 model and utilized to calculate $[R_T]_2$, the second approximation to the thermal separation ratio from the expressions developed by Mason for the exp-six model. It has been shown that the difference between $[R_T]_1$ and $[R_T]_2$ for the 12 : 6 model is very small and does not vitiate the method developed by the authors elsewhere for calculating the force constants from the thermal diffusion data. These considerations have been applied to argon and the results compared with the experimental data. A simple empirical relation connecting $[R_T]_1$ and $[R_T]_2$ has been derived for the Lennard–Jones 12 : 6 model. A.

533.15

9477. Binary diffusion of similar or isotopic molecules in three component systems. W. P. Senett, F. Gollob and T. I. Taylor. *J. chem. Phys.*, **23**, *No.* 9, 1679–83 (*Sept.*, 1955).

The application of Maxwell's equations to obtain the diffusion coefficient for the mixing of two gases in the presence of a fixed concentration of a third leads to an inconsistency so that only an approximate solution may be obtained. Since the approximation becomes better as the diffusing species become similar, isotopic species are a favourable case. The two bulb mixing problem for isotopic gradients in each of two molecular species but no molecular gradient as a whole is now solved as two independent three component systems leading to relatively simple equations. The validity of the treatment is confirmed by a series of experiments in which agreement between the calculated relaxation time and observed one is well within the estimated error of about 5%. A.

533.16 : 536.7

9478. Flow of a compressible coolant through a channel. J. Woodrow. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. E/R* 173, 17 *pp.* (1955).

The general problem of the flow of a gas along a channel, with small variation in cross-section and a given heat-input distribution, is considered, allowing for compressibility and friction. Working in terms of the density of the gas, a differential equation for the flow is obtained. An analytical solution of this equation is obtained for the special case of uniform heat input into a uniform channel. Numerical examples for medium-velocity air and high-velocity steam, indicate that the state of the gas at the exit is mainly determined by the overall heat input, and not by its distribution. The special solution therefore gives an excellent approximation if the mean heat input is used in calculating the state at the exit. The results for high-velocity steam are compared with those obtained by a method developed by Guggenheim (1945). A.

533.27

9479. Calculation of the correction to be applied to gas isotherms measured in the presence of mercury. W. B. Jepson and J. S. Rowlinson. *J. chem. Phys.*, **23**, *No.* 9, 1599–601 (*Sept.*, 1955).

A calculation is made of the correction for the volatility of mercury which should be applied to observed pressures of compressed gases, when mercury is used as the confining fluid. The usual correction is simply the subtraction of the normal vapour pressure of mercury corrected for the effect of hydrostatic pressure (the Poynting effect). It is shown that this is an inadequate treatment of the problem, as the mixture of mercury atoms and compressed gas cannot behave as an ideal mixture. An estimation of the intermolecular forces between mercury atoms and the added gas leads to values of the virial coefficients from which a revised correction can be computed, assuming that the system is at equilibrium. This revised correction can be considerably larger than the usual correction and is often of opposite sign. A.

533.5

9480. The molecular flow conductance of a pipe of elliptical cross-section. A. H. Turnbull. *Atomic Energy Res. Establ.* [*Harwell*] *Mem. GP/M*182, 5 *pp.* (1955).

The molecular flow conductance for air at room temperature of a pipe of elliptical cross-section is calculated. End effects are neglected on the assumption that the pipe is long compared with the major axis of the ellipse. A.

533.6.011.31

9481. Application of the thin-wing-expansion method to the compressible flow past a Kaplan bump. Y. Matunobu. *J. Phys. Soc. Japan*, **10**, *No.* 9, 814–21 (*Sept.*, 1955).

About ten years ago Kaplan calculated the velocity distribution over a certain cusped aerofoil set in a compressible flow as far as $O(t^3)$, t being the thickness ratio. Here the same problem is reinvestigated by use of the thin-wing-expansion method due to Imai, which is believed to be more convenient than the usual perturbation method. Both results completely agree with each other in the analytical expressions, although the labour is considerably less in the present analysis than Kaplan's. A.

533.6.011.4

9482. The supersonic motion of a Chaplygin gas. F.-K. Chuang. *Scientia Sinica*, **4**, *No.* 2, 277–96 (*June*, 1955).

The supersonic motion of a Chaplygin gas—a hypothetical gas whose density varies linearly with the pressure—is discussed mathematically. The Chaplygin application to supersonic flow is used (see Kármán and Tsien, *J. Aero Sci.*, *No.* 12), and it is shown that the equations can be reduced to wave equations; the method used by Christianovich can be regarded as a special case of the present treatment. The practical significance of the paper is that as the pressure-variation in the flow field is small, the actual pressure/specific volume graph can be replaced by tangents at points on the graph. It is shown that the Chaplygin approximation does not give satisfactory solutions in the slightly-supersonic region of flow; in such case the equations of motion are reduced to the Tricomi equations, and a general solution in the hodograph plane is obtained. J. S. G. THOMAS

MOLECULAR THEORY OF GASES 533.7

533.7

9483. Thermal conductivity, viscosity, and diffusion in gaseous phase. X. Relation between the coefficients describing these phenomena and Maxwell's equation. L. ANDRUSSOW. *J. Chim. phys.*, **52**, *No.* 4, 295–306 (*April*, 1955) In French.

The author's formulae are shown to approximate better to experimental data than Eucken's formulae, and also to explain better the relation between thermal conductivity and viscosity of binary gas mixtures.

A. GELBTUCH

533.7

9484. Second virial coefficient [$B(T)$] for ellipsoids with imbedded dipoles. C. MUCKENFUSS, C. F. CURTISS AND R. B. BIRD. Letter in *J. chem. Phys.*, **23**, *No.* 8, 1542–3 (*Aug.*, 1955).

$B(T)$ is calculated for rigid ellipsoids of revolution with point dipoles embedded along the axis of revolution, by expanding the distance between the centres of the ellipsoids when they are in contact in powers of the eccentricity. The results are displayed graphically and show that shape effects have a considerable influence on $B(T)$ for elongated or flattened polar molecules. E. H. SONDHEIMER

533.7

9485. Method of extrapolating equation-of-state data to higher temperatures. R. A. STREHLOW. Letter in *J. chem. Phys.*, **23**, *No.* 8, 1562 (*Aug.*, 1955).

High-pressure data are extrapolated by plotting $Z = PV/RT$ against $1/T$ at constant pressure, the slope of the line for $T \sim \infty$ being obtained from the virial equation of state and calculations of the virial coefficients based on the Lennard–Jones 6–12 potential model. The method gives accurate results for A and N_2, but is less satisfactory for CO_2.

E. H. SONDHEIMER

533.75 : 533.12

9486. Some low-pressure measurements of the isothermals of xenon between 0 and 40°C and the normal density of the gas. C. G. REEVES AND R. WHYTLAW-GRAY. *Proc. Roy. Soc. A*, **232**, 173–83 (*Oct.* 25, 1955).

Taking pure nitrogen as standard the deviations of xenon from the gas laws have been measured at pressures below atmospheric and at temperatures between 0 and 40°c. The density of the gas has been determined in terms of nitrogen using the microbalance technique. Combination of the data enables the density of xenon to be calculated accurately at any temperature and pressure within the limits studied and furnishes a value for the molecular weight in close agreement with that based on the mass spectrograph.

A.

VIBRATIONS . ACOUSTICS 534

534.121

9487. On the lowest flexural resonant frequency of a circular disk of linearly varying thickness driven at its center. E. G. THURSTON AND Y. T. TSUI *J Acoust. Soc. Amer.*, **27**, *No.* 5, 926–30 (*Sept.*, 1955).

A solution for the lowest, flexural, resonant frequency of a centre-driven, circular disk of linearly varying thickness is obtained by application of the Rayleigh–Ritz method. Experimental results obtained with a series of aluminium disks are given and compared with those predicted by the analysis. A.

534.121.1

9488. Air circulations about a vibrating plate. M. D. WALLER. *Brit. J. appl. Phys.*, **6**, *No.* 10, 347–8 (*Oct.*, 1955).

Fine powders are employed, as in Faraday's experiments, to observe the air circulations above a vibrating plate. The surface streaming, which occurs away from nodal lines and also inwards from the edges, is recorded by means of a mixed heterogeneous powder. Surface streamings from the side edges of a bar give rise to four circulations; compare results of other experiments in which there is relative oscillatory motion between a solid, e.g. a cylinder or reed, and a fluid. The senses of these circulations are, in the present instance, the same as those of Andrade's four-fold smoke vortices. A.

534.133

9489. Low-frequency vibrations of rectangular ADP plates. I. ŠOLC. *Czech. J. Phys.*, **5**, *No.* 2, 245–71 (*April*, 1955). In Russian, with summary in English ($1\frac{1}{2}$ *pp*).

The nodal patterns were examined with dust figures and the resonant frequency identified electrically. The work is divided into four sections, (1) Identification of flexural and longitudinal modes in plates 20 mm × 20 mm × 4 mm rotated around the X-axis in 10° steps from 1° to 90° from the Y-axis. (2) The frequency dependence on the angle of cut was determined and compared with theory. Discrepancies were observed for the longitudinal modes, (3) Flexural modes were followed in the transition from plate to bar form. It was found that to each flexural mode of the plate there corresponds either a torsional mode of the bar, or a flexural mode, or that there is no continuation. (4) Longitudinal modes were followed in the same way. There is a direct correspondence between bar and plate. W. BARDSLEY

534.141.4

9490. Theory of vortex whistle. I. MICHELSON. *J. Acoust. Soc. Amer.*, **27**, *No.* 5, 930–2 (*Sept.*, 1955).

The characteristic feature of Vonnegut's vortex whistle is the proportionality of pitch to flow rate [Abstr. 3198 (1954)], in contrast with more common types of whistles in which geometry determines the pitch. A formula for the performance of vortex whistles was proposed by its discoverer on the basis of tests; it is confirmed here on the basis of elementary physical considerations which show that high velocity and multi-dimensionality of the jet are essential. A.

534.213.4

9491. Attenuation of the (1, 0) and (2, 0) modes in rectangular ducts. A. M. GHABRIAL. *Acustica*, **5**, *No.* 3, 187–92 (1955).

The attenuation constant of the (1, 0) and the (2, 0) modes of a rectangular duct have been studied in the frequency range 1 180–3 400 c/s. A rectangular duct, confining a constant volume between a source and a reflector, is constrained to move between fixed rails.

The various modes are excited by the "hole" method and the sound field within the duct is surveyed by a probe microphone small enough not to disturb the sound field. The standing-wave ratio is measured by a resonance peak method which has the advantage of avoiding the need to delineate the complete standing-wave pattern along the tube, and it is suitable for determining small attenuations which is the case in this work. The experimental attenuation constants for the (1, 0) and the (2, 0) modes agree with the theory of Beatty within 1%. A.

534.22/23

9492. Velocity of propagation and absorption coefficient of ultrasonics in mesomorphic liquids. I. Gabrielli and L. Verdini. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 3, 426–41 (*Sept.*, 1955) In Italian.

The velocity of propagation and the absorption coefficient of ultrasonics in para-azoxyanisole and in cholesterol-benzoate have been measured as a function of temperature, by means of a pulsed-wave method. These substances present a mesomorphic phase with special optical and structural characters. From density measurements the adiabatic compressibility and the molecular sound velocity have been calculated. The para-azoxyanisole shows a peculiar temperature dependence of ultrasonic velocity, absorption and molecular sound velocity. The maxima of compressibility and of absorption coefficient at the transition temperature from mesomorphic to isotropic liquid phase are particularly noticeable. No remarkable unusual behaviour for cholesterol-benzoate has been found. The differences between the two liquid crystals (nematic and cholesteric) in ultrasonic field are briefly discussed. A.

534.222.2

9493. Instrument to study relaxation rates behind shock waves. E. L. Resler, Jr and M. Scheibe. *J. Acoust. Soc. Amer.*, **27**, *No.* 5, 932–9 (*Sept.*, 1955).

An instrument is described which combines the schlieren technique, a photomultiplier tube and an oscilloscope in a manner that enables one to measure the density distribution behind shock waves (in gases) produced in a shock tube. From these measured distributions one can determine the way in which the gas or gases relax to equilibrium and the time it takes to reach equilibrium after the gas's enthalpy is increased suddenly a calculable amount in passing through the shock wave. The theory of the instrument is discussed and its predicted performance verified experimentally by measuring vibrational heat capacity relaxation times behind shock waves in CO_2 containing water vapour. The instrument in the reported tests demonstrated a sensitivity sufficient to record a change in atmospheric density of $\frac{1}{2}$% over 1 mm distance and a space resolution of the density in the shock tube of 1/10 mm corresponding to times of the order of 1/10 μsec. A.

534.222.2 : 535.551

9494. Photoelastic shock investigations on thin glass bars. H. Schwieger. *Ann. Phys.* [*Leipzig*] **16**, *No.* 3–4, 119–33 (1955) In German.

One end of a glass (or Perspex) bar 120 mm long and 5 mm square section was fixed, and the other end was struck by a similar bar moving at about 100 cm/sec. The pressure variation at a series of points along the fixed bar was measured by photoelectric recording of the variation in intensity of a monochromatic light beam traversing the bar and two crossed Polaroids. Good quantitative agreement was obtained with theoretical prediction of duration and magnitude of the pressure pulse: discrepancies noticed were (*a*) rounding of the pulse front, attributed to amplifier characteristics and to finite acceleration time of the surface of impact; (*b*) imperfect reflection of the shock wave from the fixed end of the bar, attributed to losses arising from shock propagation into the thrust block to which the end was attached. A. Schofield

534.23

9495. Ultrasonic shutter. C. L. Darner and R. J. Bobber. *J. Acoust. Soc. Amer.*, **27**, *No.* 5, 908–13 (*Sept.*, 1955).

The ultrasonic shutter is a thickness-expander plate of barium titanate which when placed in a beam of ultra-sound, will control the transmission of sound through it over a 40 db range near the frequency of half-wave resonance. Control is exerted by means of a passive electrical network connected directly to the plate electrodes. Theory of the "shutter effect" and supporting experimental data are presented. A.

534.23

9496. Absorption of ultrasonics in mixtures of gas containing hydrogen. S. Petralia. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 2, 241–54 (*Aug.*, 1955) In Italian.

Absorption measurements were made in pure hydrogen and in mixtures of hydrogen and argon, hydrogen and oxygen in order to study the influence of extraneous gases on the rotational relaxation time of hydrogen and to verify if Kohler's theory of the classical type of absorption, holding for mixtures of monoatomic gases, could be extended to the case of biatomic gases. The effect of the presence of biatomic impurities in strong concentration is to shorten the relaxation time of hydrogen. This shortening does not exceed 10% for argon, and is much greater for oxygen. Here the relaxation time decreases continually from the value applying to hydrogen to that applying to oxygen. The author found a relaxation time for oxygen which is shorter than that given by Thaler, but which agrees with the result of a theoretical calculation by Brout. The conclusion may be drawn that Kohler's theory does not apply to the mixtures studied. A.

534.23

9497. Absorption of ultrasound in systems of partially miscible liquids. M. Cevolani and S. Petralia. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 3, 495–510 (*Sept.*, 1955) In Italian.

Using the pulse method the absorption coefficient for ultrasonics of frequency between 9 and 33 Mc/s has been measured in molten phenol, aniline, cyclohexane, in the mixtures phenol-water and phenol-cyclohexane at different concentrations of the components and at temperatures above the critical solubility temperature; the absorption in these mixtures in critical conditions has also been measured. In phenol and aniline the absorption diminishes with

increasing temperature, as with their viscosity absorption and therefore the excess of absorption as compared to the classical value ought to be ascribed to structural reasons; in cyclohexane the absorption increases with increasing temperature. The mixtures show an absorption maximum for the concentrations at which the corresponding solubility curve has a flat region; this maximum diminishes with increasing temperature and does not depend quadratically from the ultrasonic frequency. At the critical point there is a considerable absorption which is interpreted as due to relaxation processes with different frequencies; in the case of the mixture aniline-cyclohexane the relaxation frequencies fall in the field of frequencies explored. See also Abstr. 5276 (1955). A.

534.23 : 532.74

9498. Ultrasound absorption in binary liquid mixtures with dimeric associating components. W. Maier and H. D. Rudolph. Note in *Z. Naturforsch.*, **10a**, *No.* 7, 588–9 (1955) In German.

The temperature dependence of the absorption is investigated for the special case of dimeric associating benzoic acid in CCl_4. The additional absorption is thought to be associated with the time delay before association equilibrium is reached in a rapidly vibrating field. T. C. TOYE

534.23 : 537.312.62 : 539.11

9499. Ultrasonic attenuation in metals. A. B. Pippard. *Phil. Mag.*, **46**, 1104–14 (*Oct.*, 1955).

The attenuation of ultrasonic waves by conduction electrons is analysed in terms of the free-electron model of a metal. At such low frequencies that the electronic free path is smaller than the wavelength, the result obtained agrees with that found by other authors using simpler concepts, but this agreement breaks down when the free path becomes comparable with or larger than the wavelength. At very high frequencies the attenuation of longitudinal waves increases in proportion to the frequency without limit, while that of transverse waves tends to a constant value. The drop in attenuation observed when a metal becomes superconducting is shown to present quite serious problems of interpretation, and tentative suggestions are made as to possible explanations. A.

534.23 : 541.126

9500. Effects of attenuating materials on detonation induction distances in gases. M. W. Evans, F. I. Given and W. E. Richeson, Jr. *J. appl. Phys.*, **26**, *No.* 9, 1111–13 (*Sept.*, 1955).

The effectiveness of acoustic absorbing wall materials in delaying the onset of detonation in gases is explored. Experiments are reported for stoichiometric $H_2 - O_2$ mixtures in two-inch diameter cylindrical tubes. The results show that the detonation induction distance may be increased by as much as a factor of two by making the walls of the tube of porous sintered bronze. A.

534.232

9501. On the direction factor and acoustic power-concentration of a circular [line] group of radiators. K. Feik and D. Brodhun. *Nachrichtentechnik*, **5**, *No.* 4, 149–50 (*April*, 1955) In German.

After referring to the work of Stenzel on the calculation of direction factors and of Fischer on the calculation of radiation efficiency, for various arrays of sound radiators, the author derives expressions for the radiation characteristics and power concentration of a circular (line) array of sound radiators. A. B. WOOD

534.232

9502. Analysis of Hypex horns. R. I. Ścibor-Marchocki. *J. Acoust. Soc. Amer.*, **27**, *No.* 5, 939–47 (*Sept.*, 1955).

Impedance transformations of the "Hypex" horns are derived for all cases of mismatch for both increasing and decreasing characteristic impedance. A method of using a Smith Chart for these transformations is presented. The results are applicable to cases where losses are appreciable. A.

534.232 : 534.6

9503. Two-projector null method for calibration of hydrophones at low audio and infrasonic frequencies. W. J. Trott and E. N. Lide. *J. Acoust. Soc. Amer.*, **27**, *No.* 5, 951–6 (*Sept.*, 1955).

Theory and procedure are presented on an absolute method for calibration of hydrophones in a closed water-filled tank. Unlike other absolute methods at present in use, it depends on a factor that is independent of frequency and is easily measured statically. This factor (0·1 *Bl*/area) plus voltage and current measurements yields the hydrophone free-field receiving response. The apparatus includes a displacement detecting circuit on one projector, and a means of changing phase and amplitude of the electrical current driving one projector relative to the current driving the second projector. The method has been used over the frequency range from 0·1 to 500 c/s with an accuracy in response measurement better than $\pm\frac{1}{2}$ db. A.

534.24/.25

9504. On the focusing effect of reflection and refraction in a velocity gradient. W. J. Noble. *J. Acoust. Soc. Amer.*, **27**, *No.* 5, 888–91 (*Sept.*, 1955).

The divergence factor, which is of importance in the reflection of waves from a convex spherical surface, is shown to have its counterpart in plane reflection and refraction in the presence of a velocity gradient. Within a small angle approximation, a linear velocity gradient gives the ordinary spherical spreading of a pencil of rays; any discontinuity of gradient causes a divergence or convergence of the pencil. Analytical expressions and tables of typical values are calculated for four different cases. A.

534.24/.25 : 534.222.2

9505. Reflection and refraction of acoustic waves by a shock wave. J. Brillouin. *Acustica*, **5**, *No.* 3, 149–63 (1955) In French.

Sound waves in one or other of the fluid regions on either side of a shock wave are made apparent in the region under excess pressure by acoustic waves (reflected or refracted according as the incident waves lie in the region of pressure excess or defect) and by thermal waves. The characteristics of these waves are calculated for a plane, progressive, uniform incident wave. In the refracted case, the refracted acoustic wave can, according to the incidence, be plane, progressive and uniform or take the form of an

onde d'accompagnement which remains attached to the front of the shock while sliding parallel to it. Geometric constructions allow in each case the kinematic characteristics of the reflected or refracted acoustic waves to be determined. Dynamic relationships show that the amplitude of the reflected wave is always less than, but that of the refracted wave in certain cases greater than, the amplitude of the incident wave. A.

534.26 : 535.42 : 538.566

9506. A theory of the diffraction of a scalar wave by a plane screen. J. Pachner. *Czech. J. Phys.*, **5**, *No.* 3, 305–39 (*Aug.*, 1955).

The theory extends the well-known Kirchhoff solution of the diffraction problem of a scalar wave by an infinitesimally thin plane screen to arbitrarily long wavelengths. The resultant field is given by the superposition of two fields. The first of them, called the Kirchhoff approximation, is continuous across the aperture but does not fulfil the boundary condition on the screen. The second field is also continuous across the aperture but at the same time it takes such values on the screen that the resultant field then satisfies the boundary condition also on the screen. The solution is exact if the aperture is circular, while for apertures of arbitrary shape it is merely approximate. The paper contains a general section which is followed by the solution of seven special diffraction problems. Two numerical examples are also given. In Appendix I a new expansion for a spherical wave is deduced which is important for the evaluation of the Kirchhoff and Rayleigh formulae. The matrix representation of some bra-vectors, ket-vectors and linear operators used here for an abstract description of the wave fields is given in Appendix II. Appendix III deals with some relations from the theory of associated Legendre functions which are of general validity. A.

534.374

9507. Acoustic filter for classroom use. J. E. White. *Amer. J. Phys.*, **23**, *No.* 7, 464–7 (*Oct.*, 1955).

Describes an acoustic source with a primarily resistive output impedance, a microphone assembly which serves as a primarily resistive load impedance and detector and a low-pass acoustic filter designed to match them. The analogous electrical filter was built, and the performance characteristics of the two filters are compared. A.

534.39

9508. Attractive and repulsive forces between spheres in a sound field. W. Dörr. *Acustica*, **5**, *No.* 3, 163–6 (1955) In German.

The forces that arise between two spheres in a stationary sound wave are measured, especially for distances between the spheres comparable with their diameters, for which König's formula is not valid. From the measurements, a correction ΔK is found for König's formula which agrees in form with a theoretically derived formula, in respect of dependence on distance, sphere size and velocity amplitude. The variation with the angle θ between the line joining the spheres and the axis of motion is not in agreement; the experiments would make ΔK increase, the theory decrease with θ. A.

534.39

9509. Acoustic radiation pressure on a compressible sphere. K. Yosioka and Y. Kawasima. *Acustica*, **5**, *No.* 3, 167–73 (1955).

Calculations are given of the acoustic radiation pressure on compressible spheres suspended freely in a plane progressive or plane stationary sound wave field in a non-viscous fluid. With plane progressive waves the radiation pressure on bubbles shows a prominent peak corresponding to resonance in the pulsation mode. With plane stationary waves, on the contrary, the radiation pressure on the resonant bubble vanishes and the directions of the pressure are such that the bubbles smaller than the resonant are forced towards the nodes and the larger ones towards the loops. On small spheres, of which the densities are of the same order as that of the surrounding medium, such phenomena in the radiation pressure disappear and the formulae contain the density-compressibility factors instead of King's density factors. A.

534.39

9510. Acoustic radiation pressure on bubbles and their logarithmic decrement. K. Yosioka, Y. Kawasima and H. Hirano. *Acustica*, **5**, *No.* 3, 173–8 (1955).

Radiation pressure on bubbles in a plane progressive sound wave field is calculated taking the effect of heat conduction into account. At 70 and 120 kc/s in water, measurements were made on H_2 and O_2 bubbles. The result of the experiment is in good agreement with theory, showing a prominent peak corresponding to the pulsation resonance. Logarithmic decrements of the resonant bubbles deduced from the data on radiation pressure are also in good agreement with the theory of Pfriem and Saneyoshi. In the case of plane stationary waves, bubbles smaller than the resonant are found to accumulate at the nodes and larger ones at the loops, as expected from the authors' calculations, while the radiation pressure on the resonant bubble vanishes. A.

534.39

9511. Experimental studies on acoustic radiation pressure. E. M. J. Herrey. *J. Acoust. Soc. Amer.*, **27**, *No.* 5, 891–7 (*Sept.*, 1955).

An apparatus is described which allows one to measure the normal and shearing component of the force of radiation pressure exerted by an ultrasonic beam through water on an intercepting disk. Results of measurements on an absorbing and on a reflecting disk are seen to confirm the theory of Brillouin that radiation pressure is due to a state of unidirectional stress in the region of a plane progressive wave and that it is properly represented by an anisotropic stress tensor. It also appears that the apparatus with the absorbing disk provides a very simple, and at the same time, accurate device for the absolute measurement of the power output of an acoustic transducer. Furthermore, it is shown how the measurement of radiation force components with this apparatus can be used for the determination of the average reflection-, transmission- and absorption-coefficients of any sample material as functions of angle of incidence. Results of measurements on cork, aluminium and steel plates are presented. A.

534.39 : 532.528

9512. Production of accelerated cavitation damage by an acoustic field in a cylindrical cavity. A. T. Ellis. *J. Acoust. Soc. Amer.*, **27**, *No.* 5, 913–22 (*Sept.*, 1955).

A convenient and economical method for the production of cavitation damage is described. Cavitation is generated in the region of the maximum pressure amplitude of an acoustic field in a resonant cylindrical container. The specimen surface to be damaged is a stationary boundary in the system and is therefore not subject to accelerations such as occur in conventional magnetostriction devices for cavitation damage study. The absence of these accelerations eliminates any possibility of premature material removal from cavitation weakened surfaces. Mathematical analysis of the dynamics of cavitation should also be facilitated. It is shown that simple assumptions lead to an acoustical theory agreeing with experiment to within the accuracy required. Examples are given of the application of this technique to the study of both easily damaged and highly resistant materials. Relatively uniform damage is achieved which is particularly suitable for X-ray diffraction study of the surface. Alternatively, perturbation of the acoustic field to permit concentrated damage is obtained by forming the specimen surface as the end of a small cylinder. Photomicrographic studies of damage to both monocrystalline and polycrystalline materials have been initiated with the aid of this apparatus. Cavitation experiments have been done in water with an air atmosphere and in toluene with a helium atmosphere. These experiments show that severe damage can result even if a chemically inert environment is employed. A.

534.7

Physiological acoustics. Hearing. *See also under* "Medical science. Human physiology." Decimal classification 612.85

534.78

9513. Listening to differentially filtered competing voice messages. W. Spieth and J. C. Webster. *J. Acoust. Soc. Amer.*, **27**, *No.* 5, 866–72 (*Sept.*, 1955).

An attempt was made to improve listeners' ability to respond to one of two or more simultaneous or overlapping voice messages by differentially filtering the competing message channels. The limits of satisfactory intelligibility of two digits and two International Civil Aeronautics Organization (ICAO) phonetic alphabet words in a message also containing an address were determined under various conditions of high- and low-pass filtering and speech-to-noise ratios (S/N). Within these limits, several amounts of filtering were tried in various combinations. When performance on differentially filtered competing messages was compared with performance on unfiltered competing messages, it was found that differential filtering almost always improved performance. This was true regardless of whether it was the desired message that was filtered or whether it was one or more of the competing messages that was filtered, and the degree of filtering was relatively uncritical. High-pass cut-offs of 565, 800 or 1130 c/s were about equally effective and were considerably better than high-pass cutoffs at or below 280 c/s. Low-pass cutoffs of 1600, 1130 and 800 c/s also improved performance substantially. A.

534.78

9514. Comparison of hyponasality, hypernasality, and normal voice quality on the intelligibility of two-digit numbers. H. M. Moser, J. J. Dreher and S. Adler. *J. Acoust. Soc. Amer.*, **27**, *No.* 5, 872–4 (*Sept.*, 1955).

Six Eastern and General American speakers, using hyponasal, hypernasal and normal voice qualities recorded random lists of two-digit numbers for presentation in noise to 11 trained listeners, all of whom had 32 hours practice in listening and testing in noise. Results indicate that, while voice qualities acted in a relatively similar manner at both signal-to-noise ratios tested, hypernasality was destructive to intelligibility under both conditions, hyponasality was destructive at the milder noise level, and normal delivery was best throughout. A.

534.78

9515. Phonemic confusion vectors. H. M. Moser and J. J. Dreher. *J. Acoust. Soc. Amer.*, **27**, *No.* 5, 874–82 (*Sept.*, 1955).

Test responses of listeners from 27 countries who were tested over a period of a year and a half on several versions of word spelling alphabets are examined to determine patterns of intraensemble confusion. On the word level, confusion seems to hinge on the accented vowel, and these confusions are stratified according to the articulatory position of the vowel. Greater discrimination for front vowels than for back is noted, as well as diminishing intra-ensemble confusion from high-to-low-articulatory position. A method for computing confusion vectors is presented along with a rationale for increasing the phonemic stability of any particular set of words. A.

534.78

9516. Auditory testing of a simplified description of vowel articulation. A. S. House and K. N. Stevens. *J. Acoust. Soc. Amer.*, **27**, *No.* 5, 882–8 (*Sept.*, 1955).

An auditory test to establish the adequacy of an idealized specification of vowel articulation is described. Articulatory configurations of the vocal tract are specified by means of three numbers: the position of the point of greatest constriction, the degree of constriction at that point and the size of the mouth opening. The stimuli in the recorded test are the outputs of 279 such configurations of an electrical vocal-tract analogue. All sound samples are highly similar in duration, intensity, start-stop characteristics and fundamental frequency and inflection. The instructions to subjects are standardized, and are of two types: one restricts responses to one of nine vowel categories while the other permits a non-vowel response as well. Subjects were experienced in phonetic transcription. The ranges of articulatory configurations identified as given vowels by the subjects are plotted as contours, and these data are compared to results of other investigators. Certain disagreements are pointed out and discussed. The results, in general, show good agreement with previous data, and demonstrate, therefore, the adequacy of the three-number articulatory description. A.

534.782

9517. Vowel synthesis by means of resonant circuits. E. S. WEIBEL. *J. Acoust. Soc. Amer.*, **27**, *No.* 5, 858–66 (*Sept.*, 1955).

Various ways of creating artificial vowels are discussed and compared from the viewpoint of coding efficiency. A method which requires seven parameters to specify any vowel is then introduced and described in detail. It is based on the realization of the transfer impedance of a nonuniform transmission line by lumped elements. A.

534.79 : 534.61

9518. The measurement of loudness. S. S. STEVENS. *J. Acoust. Soc. Amer.*, **27**, *No.* 5, 815–30 (*Sept.*, 1955).

Reviews the available evidence (published and unpublished) on the relation between loudness and stimulus intensity. The evidence suggests that for the typical listener the loudness L of a 1 000-cycle tone can be approximated by a power function of intensity I, of which the exponent is $\log_{10} 2$. The equation is: $L = kI^{0\cdot3}$. Intensity here is assumed to be proportional to the square of the sound pressure. In terms of *sones*, were 1 sone is the loudness produced by a tone at 40 db above the standard reference level, the equation for loudness L as a function of the number of decibels N becomes: $\log L = 0\cdot03N - 1\cdot2$. Otherwise said, a loudness ratio of 2 : 1 is produced by a pair of stimuli that differ by 10 db, and this relation appears to hold over the entire range of audible intensities. At low levels of intensity, the loudness of white noise grows more rapidly than the loudness of a 1 000-cycle tone, but above the level of approximately 50 db the two loudnesses remain more nearly proportional. The suggestion is made that for all levels greater than 50 db the loudness of continuous noises may be calculated from the equation: $\log L = 0\cdot03N + S$, where S is a spectrum parameter to be determined empirically. A.

534.833

9519. Use of flat splitter construction in aviation test cell silencing. M. HIRSCHORN. *J. Acoust. Soc. Amer.*, **27**, *No.* 5, 969–74 (*Sept.*, 1955).

A scale model of a 16 ft × 16 ft vertical test cell was constructed for the purpose of testing acoustic attenuation characteristics of various splitter configurations. The result was a system with a reverse stagger pattern and expansion chambers having high acoustic attenuation characteristics. The scale model results were verified by full-scale tests with a jet engine as a noise source. A.

534.833.1

9520. New method of recording the sound transmission loss of walls as a continuous function of frequency. R. V. WATERHOUSE AND R. K. COOK. *J. Acoust. Soc. Amer.*, **27**, *No.* 5, 967–9 (*Sept.*, 1955).

An apparatus has been developed which records as a continuous function of frequency the difference in decibels between the sound levels in two rooms separated by the partition under test. The quantity recorded differs from the transmission loss only by a small correction for the Quiet-room absorption and partition area. Experimental results are presented. An electronic potentiometer recorder is used as a self-balancing device. The voltages produced by microphones in the Loud and Quiet rooms are applied to the recorder, which drives a logarithmic attenuator and continuously reduces the Loud voltage to the same value as the Quiet voltage. The voltages are balanced at an attenuator setting which is determined by the sound transmission loss and this is plotted linearly in db on an 11-inch scale, which may be chosen as 0–60 db or less. A.

534.834

9521. Measurements of the reflection of flexural waves at changes of cross-section in rods. MUGIONO. *Acustica*, **5**, *No.* 3, 182–6 (1955) In German.

The aim of this work was the investigation of the propagation of flexural waves in building structures. In the simplified one-dimensional case, i.e. for flexural waves in rods, the reflection coefficient for single and double changes in cross-section has been calculated and measured. Experiment and theory show good agreement. A.

534.844.5

9522. The optimum reverberation time for studios. W. REICHARDT, E. KOHLSDORF AND H. MUTSCHER. *Hochfrequenztech. u. ElektAkust.*, **64**, *No.* 1, 18–25 (*July*, 1955). Also in *Wiss. Z. Tech. Hochsch. Dresden*, **4**, *No.* 2, 323–9 (1954–55) In German.

An investigation is described in which magnetic recorders are used to introduce controllable amounts of reverberation into sounds picked up in a small "dead" room. The types of sounds used included grand operatic music, chamber music and speech. The optimum reverberation time was judged by a large number of observers. Although estimates of the optimum reverberation time varied considerably the overall results indicated that the usual "school-definition" of optimum reverberation time gives a correct average value. A somewhat higher value appears to be advantageous in the range of low frequencies. A. B. WOOD

534.88

9523. Continuous tone underwater reverberation. P. CONLEY. *J. Acoust. Soc. Amer.*, **27**, *No.* 5, 962–7 (*Sept.*, 1955).

Continuous tone underwater reverberation is the signal observed when the transmitting and receiving transducers are in linear motion, the transmitter is operating at a single frequency, and no major reflecting bodies are in the beam paths. This reverberation has been measured as a function of frequency for ocean depths of 9·5 to 85·7 meters, at transducer speeds up to 7·5 meters per second, and for various sea states. The techniques for measurements are described, and some typical reverberation spectra are shown. The spectra are shown having maxima at approximately the frequency corresponding to the Doppler shift caused by the transducer motion. The spectra are asymmetrical about the maximum, with the general reverberation level decreasing with increasing depth and decreasing sea state. A.

534.88

9524. Theory of continuous-tone reverberation. G. A. KLOTZBAUGH. *J. Acoust. Soc. Amer.*, **27**, *No.* 5, 956–62 (*Sept.*, 1955).

The shape of the reverberation curve described in the paper reported in the preceding abstract can be

explained if the scatterers in water are assumed to be in motion. The reverberation is assumed to arise from a surface layer and from the main volume of the water. Formulae are given for the two components of reverberation. As an alternative, reverberation may be described in terms of general fluctuations in propagation conditions. A.

OPTICS . RADIATION . SPECTRA 535

535.14

9525. Must the photon mass be zero? L. Bass and E. Schrödinger. *Proc. Roy. Soc. A*, **232**, 1–6 (*Oct.* 11, 1955).

The old query concerning longitudinal waves, which already beset the elastic theory of light, has in our day revived in the form expressed in the title. Maxwell's field laws are a singular limiting case in that they admit but transverse waves. If this held only in however close an approximation, some fundamental laws of radiation would seem to be affected by a factor $\frac{3}{2}$, on account of the "third degree of freedom." If so, this would render even Maxwell's theory suspect, for it is difficult to accept as an adequate description of nature a limiting case whose predictions differ grossly and discontinuously from those reached by a sufficiently close approach to the limit. It is shown here in the simple, if fictitious, example of an ideal conductor, that by extending Proca's field equations in a plausible fashion to the interior of matter the discontinuity is avoided and the correct factors (not $\frac{3}{2}$ thereof) are already reached with a rest-mass at the upper limit, imposed anyhow by other well-known considerations. A.

535.241.3

9526. Even illumination from a pair of lamps. A. Marriage. *Royal Photographic Society International Conference* [*London*] 220–3. See Abstr. 7586 (1955).

The illumination along a strip in a plane can, for a given degree of uniformity, be increased twenty or more times by using a pair of lamps instead of one. Graphs are given from which the dimensions of the system can be determined for a given degree of uniformity. A.

535.241.41

9527. Instrument for determining the relative pulsations of luminous fluxes. N. N. Tkachuk and N. A. Tolstoĭ. *Svetotekhnika, No.* 2, 27–9 (1955) In Russian.

535.242

9528. Determination of the contrast sensitivity of the eye in conditions of photometric comparison. V. S. Khazanov. *Svetotekhnika, No.* 2, 13–17 (1955) In Russian.

535.247.4

9529. A simple flame-photometer of high sensitivity. G. Gergely and P. F. Váradi. *Acta phys. Hungar.*, **5**, *No.* 1, 51–64 (1955).

The photometer consists of a hydrogen-oxygen flame, a glass prism monochromator and a multiplier phototube (type 931A or IP22). The sensitivities of the measurements were: 0·6 p.p.m. for barium, 0·2 p.p.m. for strontium, 0·09 p.p.m. for calcium and 0·005 p.p.m. for potassium. The photometer was developed for the simultaneous determination of Ba, Sr and Ca content of oxide coated cathodes, and for the potassium analysis of K_2SiO_3 solutions. A simple method is described for treating the interference effects of Ba, Sr and Ca. The problems of sensitivity improvements are discussed. A.

535.247.4

9530. High-sensitivity photoelectric illumination photometer free from cosine error. O. Reeb and W. Tosberg. *Lichttechnik*, 7, *No.* 7, 275–8 (*July*, 1955) In German.

Describes an instrument in which the photovoltaic cell is used in a Campbell–Freeth circuit modified so as to require only one galvanometer. The cosine correction is obtained by the use of a collecting lens cemented to the surface of the cell and by a surrounding ring of specially designed form. The readings are little affected by temperature and the instrument is easily portable. No correction is made for colour.

J. W. T. WALSH

535.247.4 : 621.327.43

9531. Photo-electric installation for testing the colour and light characteristics of the radiation of fluorescent lamps. R. S. Ioffe and D. A. Shklover. *Svetotekhnika, No.* 2, 8–13 (1955) In Russian.

535.313

9532. The calculation of wavy-surface mirror reflectors for lighting fittings. V. V. Trembach. *Svetotekhnika, No.* 2, 17–22 (1955) In Russian.

535.313.2

9533. Application of the Rayleigh criterion to the null test of Dall–Kirkham primary mirrors. P. R. Yoder, Jr, F. B. Patrick and A. E. Gee. *J. Opt. Soc. Amer.*, **45**, *No.* 10, 881–3 (*Oct.*, 1955).

The Rayleigh tolerance on residual spherical aberration is utilized to predict the permitted error in geometrical surface figure eccentricity of the concave ellipsoidal primary mirror of a Dall–Kirkham objective system. The corresponding deviation from complete null when the conventional Foucault knife edge test at the conjugate foci is applied to this mirror is evaluated. This deviation is found to equal the Rayleigh limit of spherical aberration as computed for the particular mirror diameter and knife edge distance used. This equality is interpreted to mean that a mirror made to any criterion of perfection will function within that criterion in an otherwise perfect objective system even if the test procedure is completely foreign to the final use of the mirror. The effect of variation of secondary magnification as a means of improving the performance of the complete system is discussed. It is shown that primary surfaces slightly outside tolerance can be made to perform within tolerance by appropriate changes. A.

535.315

9534. Theory of the Hüfner rhomboid. K. D. Mielenz. *Optik*, **12**, *No.* 9, 404–10 (1955) In German.

The optical properties of the Hüfner prism, used for bringing together two separated parallel beams, are deduced. The optimum angle is shown to be 45°.

R. W. FISH

535.317

9535. Information theory and optical images. E. H. Linfoot. *J. Opt. Soc. Amer.*, **45**, *No.* 10, 808–19 (*Oct.*, 1955).

The informational aspects of optical design have attracted increasing attention in the last few years [see for example A. Blanc-Lapierre (1953), D. Gabor (1952)]. The closely related topic of the Fourier treatment of optical imaging has been discussed by P.-M. Duffieux (1946) and by Elias, Grey and Robinson (1952) among others. The present paper gives an account of analytical techniques which provide a basis for a discussion of the problem of maximizing the information content in images formed by high-quality optical systems, by means of aberration balancing under prescribed constraints on the design. A derivation is given of the principal results needed for this purpose. A.

535.317 : 535.42

9536. On object–image correspondence in optics. P. Dumontet. *Optica Acta*, **2**, *No.* 2, 53–63 (*July*, 1955) In French.

It is generally considered that for a stigmatic and aplanatic optical system the object–image amplitude relationship is that of a linear filter. The validity of this approximation is investigated, and it is shown that in many cases linear filters are only a gross approximation. A more rigorous mathematical expression for the object–image relationship is proposed, and applied to the case of imagery with partially coherent illumination. A.

535.317.25 : 522.2

9537. The resolving power of astronomical observing instruments treated by Fourier analysis. L. Berger. *J. Phys. Radium*, **16**, *No.* 6, 433–8 (*June*, 1955) In French.

Existing theories of resolving power are based upon the specific properties of certain optical instruments, usually objectives of relatively small aperture. A more rigorous theory is derived, which does not depend upon a particular instrument and is therefore quite general. From the Fourier transform applied to the intensity distribution in the object, it is shown that an instrument can give no knowledge of some components, these defining the resolving power.

R. W. FISH

535.323 : 548.7

9538. Optical anisotropy of aromatic crystals. M. N. Dutt. Letter in *J. Opt. Soc. Amer.*, **45**, *No.* 9, 770–1 (*Sept.*, 1955).

Measurements have been made, by means of the Becke method, of the refractive indices of several organic compounds. The results for the three principal directions α, β and γ respectively are as follows, anthraquinone (monoclinic), 1·816, 1·698, 1·506; *m*-dinitrobenzene (orthorhombic), 1·692, 1·689, 1·499; naphthalene tetrachloride (monoclinic), 1·793, 1·775, 1·534; *m*-aminophenol (orthorhombic), 1·638, 1·625, 1·505. The results are interpreted with regard to the probable orientation of the benzene rings in the crystals. J. IBALL

535.33

9539. Dependence of resolving limit on stage of resolution when line width due to natural damping is large. S. S. Mitra. Letter in *J. sci. industr. Res.*, **14B**, *No.* 6, 303–4 (*June*, 1955).

A relationship is found between the limit of resolution and the stage of resolution, i.e. the assumed ratio of minimum and maximum intensity in the image, for spectral lines whose width is governed by damping alone. R. W. FISH

535.33

9540. Simple graphical method of correcting for instrumental broadening. R. N. Bracewell. *J. Opt. Soc. Amer.*, **45**, *No.* 10, 873–6 (*Oct.*, 1955).

A method is presented for correcting the function $g(x)$ which results when measurements on a wanted function $f(x)$ are subject to instrumental broadening. The essence of the method lies in its simplicity, which especially suits it for application to the correction of stellar molecular spectra and similar cases where the complexity or quality of the data does not warrant undue expenditure of effort. As a basis for the method, the paper establishes a finite-difference solution of the integral equation in the form $g + \Sigma U_n \Delta^n g$. From this it is deduced that the correction to the curve g at the point P is proportional to the amount by which the mid-point of a certain chord falls below P. Both the span of the chord and the constant of proportionality are independent of the abscissa x; they may be calculated from the instrumental profile. A.

535.33

9541. Provisional wavelength standards in the vacuum ultraviolet. P. G. Wilkinson. *J. Opt. Soc. Amer.*, **45**, *No.* 10, 862–7 (*Oct.*, 1955).

The wavelengths of 245 atomic emission lines, mainly C, N and O, and commonly occurring as impurities in conventional light sources, have been measured from 875 Å to 1 940 Å in the first order of a 21 ft vacuum grating spectrograph with a dispersion of 1·3 Å per mm. Cu II, Fe I and Fe II lines, whose wavelengths can be calculated accurately by the combination principle, were used as standards. The present work expands the number of previously known vacuum ultraviolet provisional standards and places them on a consistent wavelength scale with an average internal error of $\pm 0{\cdot}003$ Å, and an absolute error of less than $\pm 0{\cdot}005$ Å. A.

535.33.07

9542. Principles of a new infrared spectrophotometer. K. F. Luft and H. Maillet. *Rev. Opt.*, **33**, *No.* 12, 644–53 (*Dec.*, 1954) In French.

A double-beam recording instrument incorporates a double monochromator with NaCl prisms in Littrow mounting; preliminary dispersion with a 30° prism is followed by the main dispersion with a 60° prism and collimation with 2 concave mirrors in series to minimize coma. The 2 beams are alternated on to the slit at 5 c/s and the output from a bolometer is amplified and charges 2 condensers; the ratio of charges (i.e. specimen transmission) is recorded with a capacity potential divider consisting of uniformly rotating plates. Slits are adjusted by cams to give a constant resolving power of 670; the λ scale is logarithmic so that the wavelength resolved is represented by a fixed distance on the record. Modifications proposed for a commercial instrument are described. G. F. LOTHIAN

535.33.07

9543. The illumination of spectrographs by volume radiation. J. BRANDMÜLLER. *Optik*, **12**, *No.* 9, 389–403 (1955) In German.

When investigating Rayleigh scatter or Raman effect of liquids, it is not possible to have the entire radiating volume close to the spectrograph slit. The light entering the slit is calculated as a function of the geometry and the results are confirmed experimentally. The use of a condenser lens is shown to increase the illumination by a factor of 2. R. W. FISH

535.33.07

9544. A furnace for obtaining optical spectra of radioactive elements. L. F. H. BOVEY. *J. sci. Instrum.*, **32**, *No.* 10, 376–8 (*Oct.*, 1955).

The construction and operation of a King-type furnace for exciting spectra of radioactive or toxic materials are described. Absorption spectra of scandium, yttrium and lanthanum have been taken. Both emission and absorption spectra of uranium and plutonium have been observed within the range 2 400–7 000 Å, in the second order of a 3 m grating spectrograph. A.

535.331

9545. Third spectrum of niobium (Nb III). L. IGLESIAS. *J. Opt. Soc. Amer.*, **45**, *No.* 10, 856–61 (*Oct.*, 1955).

The spark spectrum of niobium has been photographed in the region from 540 to 3 200 Å. Seven hundred lines of the third spectrum of niobium have been measured. It has been possible to establish 58 new levels originating from the $4d^3$, $4d^25s$, $4d^25d$, $4d^26s$ and $4d^25p$ configurations and to classify a total of 319 lines. By assuming $\alpha = -4{\cdot}8\times10^{-6}$, the application of a Ritz formula to the $4d^2(^3F)ns\,^4F$ series gives 221 600 K for the value of the $4d^3\,^4F_{1\frac{1}{2}}$ level, with respect to the $4d^2(^3F_2)$ level of the Nb IV; it corresponds to an I.P. of 27·5 V. A.

535.331

9546. Standard wavelengths in copper (Cu II). A. G. SHENSTONE. *J. Opt. Soc. Amer.*, **45**, *No.* 10, 868 (*Oct.*, 1955).

New grating measurements of copper spark lines, useful as ultraviolet standards, are given. They should be measured interferometrically because of their importance in the calculation of standards for the vacuum ultraviolet. A.

535.331

9547. Preliminary description and analysis of the spectrum of polonium. G. W. CHARLES, D. J. HUNT, G. PISH AND D. L. TIMMA. *J. Opt. Soc. Amer.*, **45**, *No.* 10, 869–72 (*Oct.*, 1955).

Purified polonium has been excited by high-frequency electrodeless discharges of 10, 30 and 400 Mc/s at temperatures ranging from 200° to 800°C, and in an enclosed spark source. 139 lines have been found in the spectrum from the electrodeless discharge. 35 of these and 13 additional lines have been observed in the spectrum of the spark discharge. 48 lines have been classified as transitions involving 24 energy levels of Po I. Four levels of the fundamental configuration $6p^4$ have been identified. The observations have been compared with theoretical predictions for this configuration. Separations are well represented by theory with the parameter $F_2 = 1\,096K$ and $\zeta = 12\,379K$. The absolute value of the lowest level $6p^4\,^3P_2'$ has been estimated from the first two members of the series $^6p^3(^4S^0)ns$. An estimate of 67 980K is obtained. This corresponds to an ionization potential of 8·43 V for the neutral polonium atom. A.

535.331 : 523.755

9548. Energy levels in Ca XV. D. LAYZER. *Monthly Not. Roy. Astron. Soc.*, **114**, *No.* 6, 692–9 (1954).

A discussion of the structure of term spectra in isoelectronic sequences shows that spectral terms fall naturally into certain groups, called "complexes." A complex is completely specified by the set of principal quantum numbers (n) and the parity p, and contains one or more entire configurations. The interval between terms that belong to the same complex varies asymptotically as the nuclear charge Z for large values of Z, while the interval between terms that belong to complexes with different sets of principal quantum numbers (n) varies asymptotically as Z^2. The electrostatic coupling between configurations whose terms belong to different complexes tends to vanish with increasing Z; but the coupling between configurations whose terms belong to the same complex approaches constancy. This circumstance greatly simplifies the discussion of configuration mixing in highly ionized atoms. In Ca XV the configurations $(1s^2)(2s^2)$ $(2p^2)$ and $(1s^2)(2p^4)$ are strongly coupled, but the complex (1^22^4) is weakly coupled with higher complexes. On the approximation of zero coupling between (1^22^4) and higher complexes, the energy levels of (1^22^4) are the eigenvalues of a tenth-order matrix, which reduces to two fourth-order matrices and a second-order matrix. The matrix elements have been evaluated partly by extrapolation along the isoelectronic sequence and partly by theoretical considerations. The predicted wavelengths for the transitions $2p^2\,^3P_{2\to1}$, $^3P_{1\to0}$ are 5 456 Å and 5 650 Å respectively. These agree with the observed wavelengths of the coronal lines $\lambda\lambda$5445, 5694 to within the uncertainty of the calculation, thus confirming the identifications of Edlén and Waldmeier. A.

535.333

9549. Streamer and brush flames excited by active nitrogen in the rare gases. C. KENTY. Letter in *J. chem. Phys.*, **23**, *No.* 8, 1556–7 (*Aug.*, 1955).

Tesla discharges through rare gases containing a trace of N_2 between a pointed and flattened metal electrode (W, Mo, Ta, etc.) give streamers whose spectra show selective excitation of certain metal lines. Results are attributed to metastable N atoms and N_2 molecules. Condensed sparks give brush-like flames with 30 metals tried. The spectra show more complete excitation of metal lines but still some selective enhancement. A. G. GAYDON

535.333

9550. Active nitrogen in the rare gases and its excitation of metal vapors. C. KENTY. Letter in *J. chem. Phys.*, **23**, *No.* 8, 1555–6 (*Aug.*, 1955).

Spectra of coloured flames obtained by introducing various metal vapours into the afterglow of rare gases containing a trace of N_2 are reported and interpreted in terms of several energy carriers. These may include N_2 molecules in the metastable states w and $a'(^1\Sigma_u^-)$, and normal N_2 with high vibrational energy.

A. G. GAYDON

535.333

9551. The interpretation of intensity distributions in the N_2 second positive and N_2^+ first negative band systems. L. V. WALLACE AND R. W. NICHOLLS. Note in *J. atmos. terrest. Phys.*, **7**, *No.* 1–2, 101–5 (*Aug.*, 1955).

Photoelectric band intensities of the N_2 second-positive and N_2^+ first-negative systems, are interpreted, with the aid of Franck–Condon factors $q(v'v'')$ and r-centroids $\bar{r}_{v'v''}$ to show the dependence of the electronic transition moment $R_e(r)$ of these systems upon internuclear separations. Smoothed arrays of vibrational transition probabilities have been derived for these band systems. A.

535.333

9552. Effect of preheating on the spectra of carbon monoxide diffusion flames. A. G. GAYDON AND F. GUEDENEY. *Trans Faraday Soc.*, **51**, *Pt* 7, 894–900 (*July*, 1955).

To separate effects of pressure and temperature on the CO-flame spectrum, measurements have been made on CO + air and CO + O_2 flat diffusion flames with the gases preheated to 750°C. The intensity of the continuum increases moderately and the ultraviolet end is relatively strengthened. This continuum is interpreted as due to collisions of O and CO on a repulsive potential-energy surface. The absolute strength of the CO_2 bands is unaffected by temperature, showing that the emission is not thermal in origin. In CO + O_2 flames the O_2 Schumann–Runge bands are strengthened more than the continuum by preheating and are apparently due to thermal excitation. A.

535.333 : 535.343

9553. Infrared spectrum of two-stage cool flame of diethyl ether. R. E. DONOVAN AND W. G. AGNEW. *J. chem. Phys.*, **23**, *No.* 9, 1592–6 (*Sept.*, 1955).

An optical system has been made so that absorption and emission spectra from stages of a combustion process can be observed. Spectra from the two-stage cool flame of diethyl ether indicate that carbonyl compounds are formed as intermediates and final products are HCHO, CO_2, H_2O, CO and C_2H_4. Also identified are CH_3OH and CH_4. Temperature calculations indicate that the infrared emission from this reaction is of thermal origin in contrast to the visible emission which is undoubtedly chemiluminescence. Calculated temperatures range from 700°K in the first cool flame to ~1 000° in the second-stage flame. A.

535.333 : 536.46

Studies of chlorine trifluoride flames. *See Abstr.* 9611

535.338.4

9554. The spectrum of MnCl and MnBr in the near ultraviolet. W. HAYES AND T. E. NEVIN. *Proc. Roy. Irish Acad. A*, **57**, *No.* 2, 15–30 (*Feb.*, 1955).

The spectra of MnF, MnCl and MnBr have been photographed under high dispersion using a hollow cathode discharge and the complex band systems of MnCl and MnBr in the near ultraviolet have been remeasured. A new analysis of the observed heads has been made but the transition, in agreement with earlier work of Bacher, is still interpreted as $^7\Pi \rightarrow {}^7\Sigma$. The isotope effect observed in MnBr is discussed in detail. A.

535.338.4

9555. The emission spectrum of bromine. P. B. V. HARANATH AND P. TIRUVENGANNA RAO. *Indian J. Phys.*, **29**, *No.* 5, 205–26 (*May*, 1955).

The emission spectrum of bromine as excited by a high-frequency high-power oscillator is photographed in the visible region, λ6 400 to λ4 400 and is found to consist of as many as 300 bands as against only 80 bands reported previously by Uchida and Ota in the region λ6 700 to λ5 000. Tentative vibrational analysis of the bands on the basis of two systems suggested by Uchida and Ota are considerably extended to include all the bands down to λ4 400. This has led to a redetermination of the following vibrational constants

	ω'_e	$x'_e\omega'_e$	ω''_e	$x''_e\omega''_e$	ν_e
System I	190·0	1·0	376·0	1·25	19 290·0
System II	152·0	0·35	376·0	1·25	18 782·0

The vibrational assignments are well supported by an extensive study of the bromine isotope effect. A.

535.338.4 : 539.132

9556. Computation of intensities of vibrational spectra of electronic bands in diatomic molecules. III. A. RAHMAN. *Physica*, **21**, *No.* 8, 663–6 (*Aug.*, 1955).

Using the technique of Pt I and II [Abstr. 10944 (1954)], which provides very simple recurrence relations for the calculation of transition moments, it is shown that similar recurrence relations give the transition moments also when the purely electronic transition probability varies exponentially with the internuclear distance. The usefulness of the recurrence relations is demonstrated by computing the matrix of transition moments for the $A \leftrightarrow X$ transition of the molecule OH. A.

535.338.42

9557. Theoretical transition probabilities for C_2 Swan system. N. R. TAWDE AND V. RAJESWARY. Letter in *J. sci. industr. Res.*, **14B**, *No.* 6, 302–3 (*June*, 1955).

The value of Bates's tables [Abstr. 4787 (1954)] for the rapid computation of transition probabilities is tested in the case of the Swan bands. The results, using Bates's procedure "A," agree well with those from the more laborious Morse approximation and confirm the value of this method. D. L. EDWARDS

535.34 : 778.37

9558. High-speed photographic spectroscopy. G. PORTER. *Royal Photographic Society International Conference* [*London*] 462–5. See Abstr. 7586 (1955).

The recording of transient absorption spectra is of great importance in the study of the short-lived intermediates which occur in many chemical reactions and which cannot readily be detected or estimated by other means. Methods are now available for the preparation of such substances, for times of a few milliseconds, in sufficient concentration for the application of spectroscopic techniques. The problem of photographing the changing absorption spectrum at intervals during this time has been solved by the use of a modified electronic flash. Examples are given of the application of flash spectroscopy to chemical reactions of very short duration. A.

535.34.07

9559. Calibration and use of a cesium iodide prism in the infrared. I. M. Mills, J. R. Scherer, B. Crawford, Jr and M. Youngquist. *J. Opt. Soc. Amer.*, **45**, *No.* 10, 785–7 (*Oct.*, 1955).

With a caesium iodide prism the long wavelength range of an infrared spectrometer may be extended to 55 μ. The use of such a prism, the choice of optical system, and the problems of stray radiation are all discussed. Accurate data are assembled for calibration in this region, and sample calibration traces are shown. A simple gas absorption cell is described for use at long wavelengths. A.

535.34.07 : 545.82

9560. A new approach to infra-red instrumentation. A. G. Peacock. *Brit. Commun. and Electronics*, **2**, *No.* 6, 58–62 (*June*, 1955).

The instrument described was developed for absorption analysis of organic and other substances having their main absorption maxima in the region from 1 to 4 μ. It incorporates a new diffraction grating having 7500 lines/in. Some of the errors inherent in machine-produced gratings have been minimized by using a master produced by ruling a helix on a cylinder. The source used is a Nernst glower and the band of wavelengths entering the monochromator is restricted by passing the beam through a filtering crystal of KCl. A lead sulphide cell is used as detector up to 2·8 μ while from 2·8–4 μ a lead selenide cell is used. The light is chopped at 750 c/s by a rotating castellated drum so as to enable an a.c. amplifier to be used. This is a modified homodyne type with a correlation detector. A simple alternator provides a reference signal and only signals of the same frequency as the reference and in phase with it are rectified, so that a significant improvement in signal/noise ratio results. A second light path direct from the source to the detector is opened 50 times per sec and provides a reference which is used to stabilize the output of the amplifier, thus obviating the need for stabilized power supplies. Another gain control, using a cam-operated potentiometer, enables the λ/transmission characteristic of the source and detector combination to be compensated. The method of use and applications are discussed and a number of references to work in the field of spectrographic analysis and identification are given.

W. G. STRIPP

535.343

9561. Infrared spectra of intermediate species in the formation of ammonium azide from hydrazoic acid. D. A. Dows, G. C. Pimentel and E. Whittle. *J. chem. Phys.*, **23**, *No.* 9, 1606–9 (*Sept.*, 1955).

Infrared spectroscopic studies have been made of the solid formed when the products of the glow-discharge decomposition of hydrazoic acid are condensed on a surface cooled to 90°K. Spectra were obtained at several temperatures as the solid was allowed to warm to 230°K. The solid shows absorptions attributed to HN_3, NH_4N_3, and NH_3, and to two intermediate species in the reaction. These intermediates are interpreted to be N_2H_2 and $(NH)_x$, where x may be equal to 4. The presence of the imine radical, NH, in the solid at 90°K is inferred. A.

535.343

9562. Oxygen gas continuous absorption in the extreme ultraviolet. A. A. Aboud, J. P. Curtis, R. Mercure and W. A. Rense. Letter in *J. Opt. Soc. Amer.*, **45**, *No.* 9, 767–8 (*Sept.*, 1955).

Absorption coefficients are measured for 1000–100 Å; values for $\lambda < 300$ Å are only approx.

G. F. LOTHIAN

535.343

9563. Absorption cross sections of carbon dioxide and carbon monoxide in the vacuum ultraviolet. H. Sun and G. L. Weissler. *J. chem. Phys.*, **23**, *No.* 9, 1625–8 (*Sept.*, 1955).

Absorption cross-sections in the region from 1306 Å to 374 Å were measured. The absorption spectrum of CO_2 consists of strong resonance bands between 1306 Å and 700 Å, with one of them at 923 Å showing an unusually large cross-section of 117×10^{-18} cm^2. A continuum with bands superimposed on it was observed to start at about 860 Å or 14·4 eV which corresponded to the first ionization potential of CO_2. From 700 Å toward shorter wavelengths, the contour of the continuum was better defined and smooth with a broad maximum of 36×10^{-18} cm^2 at 550 Å and a total f-value of 4·4. The CO absorption between 1306 Å and 955 Å was less than 10^{-18} cm^2. Prominent resonance bands appeared at 924 Å and extended to 600 Å. An absorption continuum could be identified between 876 Å and 374 Å showing maximum values of $\sigma \simeq 19 \times 10^{-18}$ cm^2 between 750 Å and 550 Å with perhaps a small dip of 15×10^{-18} cm^2 at 644 Å. The f-value of this continuum was 2·8. A.

535.343 : 537.564

9564. Preliminary data on photoionization efficiencies and cross sections in C_2H_4 and C_2H_2. W. C. Walker and G. L. Weissler. Letter in *J. chem. Phys.*, **23**, *No.* 8, 1547–8 (*Aug.*, 1955).

These are reported for radiation in the region from the onset of the ionization continuum (1185 ± 5 Å for C_2H_4 and 1100 ± 5 Å for C_2H_2) to 687 Å.

W. GOOD

535.343 : 539.133

9565. Vibrational spectra and structure of cyclopropane and cyclopropane-d_6. A. W. Baker and R. C. Lord. *J. chem. Phys.*, **23**, *No.* 9, 1636–43 (*Sept.*, 1955).

Cyclopropane-d_6 has been synthesized from deuterium oxide and magnesium tricarbide in steps giving successively methyl acetylene-d_4, propylene-d_6, allyl chloride-d_5, 3-bromo-1-chloropropane-d_6, and cyclopropane-d_6. Infrared spectra of cyclopropane and cyclopropane-d_6 have been obtained in the spectral region 350 to 3700 cm^{-1} for the vapour and 650 to 3700 cm^{-1} for the liquid. Raman spectra, including semi-quantitative depolarization factors, have been determined for the liquid state. The spectroscopic results satisfy the Teller–Redlich product rule for a molecule of D_{3h} symmetry. All active fundamentals in cyclopropane-d_6 but one have been directly observed. The inactive fundamentals in both molecules have been located provisionally from overtone assignments. An attempt to determine the molecular geometry from rotational contours of the infrared

bands was not successful, but high-resolution work on cyclopropane-d_6 shows that the C–C distance is $1{\cdot}524 \pm 0{\cdot}014$ Å. A.

535.343

9566. On the structure of infrared absorption bands. H. POULET. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 25, 2395–7 (*June* 20, 1955) In French.

The positions of the secondary maxima in the infrared absorption bands of NaCl and KCl are calculated from data on the thermal scattering of X-rays and are in accord with experiment. G. F. LOTHIAN

535.343

9567. Vibration-rotation band ν_2 of heavy water vapor. F. P. DICKEY AND J. M. HOFFMAN. *J. chem. Phys.*, **23**, *No.* 9, 1718–20 (*Sept.*, 1955).

The spectrum has been remeasured and an analysis of the rotational structure carried out. From the interpretation of the data the band centre, as well as the value of the reciprocals of inertia have been determined. The band centre is found to be $1\,178{\cdot}45$ cm^{-1} and the reciprocals of inertia are $A(V) = 16{\cdot}650$ cm^{-1}, $B(V) = 7{\cdot}345\,cm^{-1}$, and $C(V) = 4{\cdot}795\,cm^{-1}$. A.

535.343 : 539.132

9568. Infrared absorption spectra of inorganic coordination complexes. III. Deformation frequencies of the NH_3 ligand. S. MIZUSHIMA, I. NAKAGAWA AND J. V. QUAGLIANO. Letter in *J. chem. Phys.*, **23**, *No.* 7, 1367–8 (*July*, 1955).

The deformation frequencies of NH_3 in several metal complexes, especially Co(III) ammines, have been determined. The observed frequencies are assigned to degenerate deformation, symmetric deformation, and rocking vibrations. G. I. W. LLEWELYN

535.343

9569. Low-frequency rotational spectrum of HDO. S. WEISBAUM, Y. BEERS AND G. HERRMANN. *J. chem. Phys.*, **23**, *No.* 9, 1601–5 (*Sept.*, 1955).

In the region between 475 and 3 500 Mc/s one *P*-branch and five *Q*-branch lines in the spectrum of HDO have been completely measured and identified. These data have contributed materially to an evaluation of the structural constants of the molecule. From the data obtained by this and other microwave spectroscopy projects the principal moments of inertia have been computed respectively as having the values of $1{\cdot}198\,2$, $3{\cdot}086\,2$, and $4{\cdot}388\,7$ in units of $g.cm^2 \times 10^{-40}$. In addition, the shape of the $3_2 \rightarrow 3_3$ line at $824{\cdot}64$ Mc/s has been extensively studied. At low pressure the wings of the line have been shown to be wider than is consistent with the Lorentz line shape probably due to the presence of satellite lines arising from the hyperfine splitting of the energy levels by the quadrupole moment of the deuteron. The observed effects are consistent with a quadrupole coupling constant of 272 ± 90 kc/s with respect to an axis along the O–D bond. A.

535.343

9570. Analysis of the $6\,140\,cm^{-1}$ band of HDS. G. A. CROSBY, E. J. BAIR AND P. C. CROSS. *J. chem. Phys.*, **23**, *No.* 9, 1660–3 (*Sept.*, 1955).

Absorption observed in the region $6\,140\,cm^{-1}$ was analysed to yield the following constants: $\nu_0 = 6\,140{\cdot}0$ cm^{-1}, $A'' = 9{\cdot}743$, $B'' = 4{\cdot}922$, $C'' = 3{\cdot}232$, $A' = 9{\cdot}411$, $B' = 5{\cdot}019$, $C' = 3{\cdot}137\,cm^{-1}$. The inertial defect of the ground state, $\Delta'' = I_C'' - I_A'' - I_B'' = 0{\cdot}101 \times 10^{-40}\,g\,cm^2$, is approximately half that estimated for use in the interpretation of the microwave spectrum. This accounts for the major part of the discrepancy between the sets of moments of inertia of the molecule obtained by the two methods. A.

535.343 : 539.152.2

9571. Fine structure of pure quadrupole spectrum in iodine crystal. S. KOJIMA AND K. TSUKADA. Note in *J. Phys. Soc. Japan*, **10**, *No.* 7, 591–2 (*July*, 1955).

The $m_z|1/2| \rightarrow |3/2|$ pure quadrupole transition near 332 Mc/s in a single 30 g crystal of I_2 was resolved into five lines with separations -24, -8, 0, 12, and 26 kc/s and intensity ratios $2:2:5:1:1$. The Zeeman pattern above 50 gauss was normal, asymmetry parameter $16 \pm 1\%$. The $|3/2| \rightarrow |5/2|$ transition near 644 Mc/s was 45 kc/s broad but devoid of fine structure. ICl and Br_2 show fine structure. D. H. WHIFFEN

535.345

9572. The absorption of ultraviolet in quartz and vitreous silica. V. GARINO-CANINA. *Rev. Opt.*, **34**, *No.* 7–8, 365–70 (*July–Aug.*, 1955) In French.

A parallel is drawn between results obtained with crystallized silica such as quartz, and with vitreous silica. The anomalously high absorption often shown by natural quartz around 2 000 Å is supposed to be due to iron and titanium impurities. A.

535.345

9573. Infrared transmission of barium titanate. C. HILSUM. Letter in *J. Opt. Soc. Amer.*, **45**, *No.* 9, 771–2 (*Sept.*, 1955).

A yellow crystal is found transparent to $7\,\mu$. G. F. LOTHIAN

535.347 : 548.7

9574. The propagation of light in absorbing biaxial crystals. I. Theoretical. S. PANCHARATNAM. *Proc. Indian Acad. Sci. A*, **42**, *No.* 2, 86–109 (*Aug.*, 1955).

The optical behaviour of pleochroic biaxial crystals in the vicinity of an optic axis can be elegantly interpreted as due to the effects of linear birefringence and linear dichroism superposed continuously along the depth of the material. This idea—followed up geometrically with the Poincaré sphere, and analytically by direct algebraic methods—explains the elliptical polarization of the two waves propagated in any general direction, as due to the non-coincidence of the principal planes for the usual operation of birefringence with those for the operation of dichroism. In particular, it also explains the existence, on either side of an optic axis, of two singular axes—along any one of which only one circular vibration with a definite sense of description can be propagated unchanged: for these directions the principal planes of absorption and refraction make angles of 45° with each other, the linear birefringence and dichroism being also equal in magnitude. An examination is also made of the effects to be expected when a circular vibration incident in the direction of a singular axis has a sense of description opposite to that which can be propagated unchanged; and it is shown that—contrary to what Voigt expected—the emergent intensity will not be either zero or negligible, but will in

fact be greater than when the sense of description of the incident vibration is reversed. A.

535.361.2

9575. An integrating sphere for measuring diffuse reflectance in the near infrared. J. A. JACQUEZ, W. MCKEEHAN, J. HUSS, J. M. DIMITROFF AND H. F. KUPPENHEIM. *J. Opt. Soc. Amer.*, **45**, *No.* 10, 781–5 (*Oct.*, 1955).

The construction and performance of a 4¼ in. diameter comparison-type integrating sphere for a spectrophotometer designed by W. L. Derksen and T. I. Monahan is described. This combination allows the measurement of diffuse spectral reflectance in the near infrared to 2·6 μ with an accuracy of 1%. A.

535.371

9576. On the fluorescence of self-activated zinc-sulphide. A. ADDAMIANO. Letter in *J. chem. Phys.*, **23**, *No.* 8, 1541 (*Aug.*, 1955).

The effect of firing temperature and time on the blue band of ZnS is investigated. Support is given to the theory of Bube [Abstr. 5039 (1952)] and of Kröger [Abstr. 2730, 3608 (1955)] that the emission centre responsible is a cation lattice vacancy.

G. F. J. GARLICK

535.371

9577. Effects of infrared on emission of ZnS : Cu phosphors. K. NAKAMURA. Note in *J. Phys. Soc. Japan*, **10**, *No.* 8, 715–16 (*Aug.*, 1955).

535.371

9578. Fluorescence quenching by blue and yellow light in a sensitized photographic emulsion. L. HORWITZ AND J. FRIEDMAN. *J. Opt. Soc. Amer.*, **45**, *No.* 10, 798 (*Oct.*, 1955).

A photographic emulsion, sensitized with 1,1′-diethyl-2,2′-cyanine iodide, fluoresces strongly when exposed to blue or yellow light. The fluorescence decreases upon pre-exposure. A difference exists in this quenching effect, depending upon whether the pre-exposure is made with blue or yellow light. A.

535.375.55 : 535.343

9579. Raman and infrared spectra and structure of 2,6-dioxaspiro(3,3)heptane. S. C. SIRKAR, F. L. VOELZ AND F. F. CLEVELAND. *J. chem. Phys*, **23**, *No.* 9, 1684–5 (*Sept.*, 1955).

The Raman spectrum of 2,6-dioxaspiro(3,3)heptane in the molten state and infrared spectra of CS_2 and CCl_4 solutions have been investigated. The polarization of the Raman lines of the liquid also has been studied. The results indicate a symmetry D_{2d} for the molecule. The appearance of two extra strongly polarized Raman lines near the 2874K line, which corresponds to the totally symmetric C–H stretching oscillation, has been accounted for by assuming Fermi resonance between overtones of C–H bending vibrations and the symmetric C–H stretching mode. A.

535.376

9580. Temperature-dependence of the light intensity waves in electroluminescence. D. HAHN AND F. W. SEEMANN. Note in *Z. Naturforsch.*, **10a**, *No.* 7, 586–7 (1955) In German.

535.376

9581. Dependence of light amplification in phosphors on light intensity. F. MATOSSI. Letter in *Phys. Rev.*, **99**, *No.* 4, 1332 (*Aug.* 15, 1955).

An extension of previous theory [Matossi, Abstr. 7327 (1954)] to interpret the enhancement of u.v. excited luminescence in a ZnS–Mn film by an applied electric field [Cusano, Abstr. 5342 (1955)].

G. F. J. GARLICK

535.376 : 537.226.2

The electrical properties of electroluminescent phosphors. *See Abstr.* 9631

535.377

9582. Thermoluminescence measurements on ZnS phosphors *in vacuo*. G. NEUMARK, J. FAJANS AND D. R. FRANKL. Letter in *J. chem. Phys.*, **23**, *No.* 8, 1553 (*Aug.*, 1955).

Although photoconductivity in ZnS and CdS is affected by surface traps due to adsorbed gases no effect is found in thermoluminescence curves.

G. F. J. GARLICK

535.39

9583. Optical properties of dielectric mirrors with obliquely incident light. F. A. KOROLEV AND A. YU. KLEMENT'EVA. *Dokl. Akad. Nauk SSSR*, **100**, *No.* 3, 459–60. In Russian.

The measured transmission for normal incidence of a 7-layer $\lambda/4$ dielectric mirror is shown graphically from 400–760 mμ. The maximum reflection (95%) is at $\lambda = 5\,600$ Å, and reflection >85% is obtained from 5 200–6 300 Å, with an absorption ~0·5%. Measurements of the transmission and reflection coefficients of the same film in unpolarized light were made for $\lambda = 6\,560$, 5 790, 5 461, 4 340 Å, at angles of incidence in the range 0–70°. For $\lambda = 5\,790$ and 5 461 Å the reflection coefficient (≃95%) is very nearly constant for angles of incidence <40°. The results are shown graphically, and were obtained using a recording spectrophotometer. H. H. HOPKINS

535.412

9584. The determination of the order of interference in white light. R. C. FAUST AND H. J. MARRINAN. *Brit. J. appl. Phys.*, **6**, *No.* 10, 351–5 (*Oct.*, 1955).

The achromatic fringe observed in white light does not necessarily correspond to the position of zero path difference, the reason being that the optical paths of the two interfering beams do not usually have the same wavelength dispersion. A general theory of this effect is presented, and it is shown how it can be applied to a Rayleigh interference refractometer, a Babinet compensator, and an interference microscope. Experimental verification of these predictions is given. A.

535.417

9585. Birefringent compensator with large field. M. FRANÇON AND B. SERGENT. *C.R. Acad. Sci. [Paris]* **241**, *No.* 1, 27–9 (*July* 4, 1955) In French.

The Babinet compensator is limited to near parallel light by the presence of isochromatic lines, which cause the order of interference to vary over the field. Compound prism arrangements are described which overcome these defects. One system has a field 26

times larger than that of the Babinet system and so can be used in eyepieces of interference microscopes.
R. W. FISH

535.417

9586. Interferometry in the infrared. R. G. GREENLER. *J. Opt. Soc. Amer.*, **45**, *No.* 10, 788–91 (*Oct.*, 1955).

Operating under the condition of energy-limited resolution in the infrared, the Fabry–Perot interferometer is shown to have a theoretical advantage by a factor of about 5 in resolving power over the diffraction grating. Tellurium films which have a high index of refraction in the infrared are shown to absorb little energy from 5 to 10 microns. Multilayer films of tellurium and potassium bromide show high reflection and low absorption, appearing to be well suited for interferometer films. Tellurium is also shown to be suitable for filters for use in the region 5 to 25 microns. A.

535.417

9587. Precision multiple-beam interference fringes with high lateral microscopic resolution. S. TOLANSKY AND S. H. EMARA. *J. Opt. Soc. Amer.*, **45**, *No.* 10, 792–5 (*Oct.*, 1955).

It is shown that very sharp multiple-beam interference fringes can be produced with a high-power 3 mm lens of numerical aperture 0·95. The optical conditions necessary to secure high definition in the fringes are discussed. The arrangement described is used with lateral magnification of $\times 1\,500$. It can resolve in extension about $0{\cdot}7\mu$ and in depth about 50 Å. The technique is illustrated by topographical studies on a dodecahedron face of a diamond. The fringes obtained are much superior to the best given by high-power two-beam interference microscopes. Volume elements as small as 5×10^{-15} cm^3 can be resolved. A.

535.417

9588. Fractional-fringe measurements with the corner-cube interferometer. E. R. PECK. *J. Opt. Soc. Amer.*, **45**, *No.* 10, 795–7 (*Oct.*, 1955).

Photoelectric fringe counting with a corner-cube interferometer is extended by interpolation to about 0·01 fringe. Means are included for setting the interferometer to a reference position with comparable accuracy. A.

535.42

9589. A generalization of the Young–Rubinowicz principle in the theory of diffraction. R. S. INGARDEN. *Acta phys. Polon.*, **14**, *No.* 1–2, 77–91 (1955).

Gives a generalization of Rubinowicz's method of decomposition of the wave behind a Kirchhoff screen into the "incident" wave u_I and the "diffracted" wave u_D for the case of an arbitrary "geometrical" wave falling on the screen. The calculations are carried out in approximation of Kirchhoff's scalar theory for an arbitrary shape of the screen. Fock's approximate solution of the wave equation (1950) is used for the incident wave. The result for u_D is a line integral containing a series expansion in powers of $1/k$ (k = the wave-number) as well as of $1/R$ (R = the distance from the integration point to the observation point) and gives Rubinowicz's formula as a special case. In the "parageometric approximation" a specially simple extension of Rubinowicz's result is obtained, being a series whose coefficients define the aberrations of the incident wave along the diffracting edge. A.

535.42 : 538.566 : 534.26

A theory of the diffraction of a scalar wave by a plane screen. *See Abstr.* 9506

535.434

9590. Charge effects in light-scattering by colloid solutions. W. PRINS AND J. J. HERMANS. Note in *J. phys. Chem.*, **59**, *No.* 6, 576 (*June*, 1955).

It is suggested that an equation relating molecular weight and turbidity which Mysels [Abstr. 9139 (1954)] regards as the most probable of three alternative answers is, on theoretical grounds, "the only answer to the problem." G. F. LOTHIAN

535.51

9591. An analyser for elliptically polarised light. S. RAMASESHAN. *J. Indian Inst. Sci. A*, **37**, *No.* 3, 195–9 (*July*, 1955).

A simple analyser for elliptically polarized light in which the half-shade principle is incorporated in the determination of both the azimuth and the ratio of the axes of the ellipse is described. A.

535.55

9592. Study of the photo-plasticity of celluloid in the form of a tube under internal pressure. E. MÖNCH AND R. JIRA. *Z. angew. Phys.*, **7**, *No.* 9, 450–3 (1955) In German.

A celluloid tube is deformed by internal pressure so that an accurately defined state of two-dimensional stress is obtained. By comparison with the results for uniaxial tension it is shown that for celluloid, as for metals, octahedral shear stress is decisive for plastic behaviour. The earlier assertion [Abstr. 234 (1955)] that the dispersion of the double-refraction can be regarded as a criterion for the degree of plastic deformation is again confirmed. H. G. JERRARD

535.551

9593. Photoelastic constants of thallium alum. K. V. KRISHNA RAO AND V. KALPAGAM. Letter in *Curr. Sci.*, **24**, *No.* 7, 228 (*July*, 1955).

Previous work [Abstr. 1742 (1955)] did not enable the individual photoelastic constants to be found. Using recently determined values of the elastic constants ($S_{11} = 49{\cdot}0$, $S_{12} = -15{\cdot}5$ and $S_{44} = 114{\cdot}8\times10^{-13}$ cm^2 dyne^{-1}) the photoelastic constants q_{11}, q_{12} and q_{13} were found to be 6·4, 12·1 and $11{\cdot}1\times10^{-13}$ cm^2 dyne^{-1} respectively. The axial tilt for stress applied along [211], observed along [011] is 33°: other alums give about 5°. H. G. JERRARD

535.551 : 539.383

9594. Apparatus for making simultaneous stress and birefringence measurements on polymers. E. F. GURNEE, L. T. PATTERSON AND R. D. ANDREWS. *J. appl. Phys.*, **26**, *No.* 9, 1106–11 (*Sept.*, 1955).

An instrument has been constructed to allow simultaneous measurements of stress and birefringence in polymer samples to be made as a function of time and temperature. The stress is measured by attaching one

end of the sample to a cantilever beam near the fulcrum; the small deflection of the beam is indicated by means of a differential transformer, which in turn is attached to an automatic recorder. The birefringence is measured with a Senarmont compensator (quarter-wave plate method). Measurements can be made either manually or with a continuously rotating analyser. This latter method permits the automatic recording of the birefringence and is also adaptable to the study of rapid birefringence changes. The sample is housed in a copper pipe surrounded by a thermostatically controlled liquid bath. Some data are presented showing the use of this apparatus in measuring birefringence and stress changes during stress relaxation experiments (sample held at constant elongation), birefringence changes during creep under constant load, and stress-optical coefficients. A.

535.65 : 612.843.31

9595. Modifications of the Wright trichromatic colorimeter for extrafoveal and peripheral observations. J. D. Moreland. *Optica Acta*, **2**, *No.* 2, 101–4 (*July*, 1955).

The conditions required for successful experiments on peripheral colour vision are discussed. These include the provision of (*a*) a foveal fixation target, (*b*) separation of the test and comparison field sufficient for resolution, (*c*) periodic flashing of the test stimulus to avoid peripheral fading. A description is then given of the modifications made to the Wright colorimeter, including the mirror assembly and perimeter attached to the observing end of the instrument to satisfy these conditions. Different field arrangements are described which can be used (*a*) to determine the spectral sensitivity, wavelength discrimination, and coefficient curves for the periphery, and (*b*) to compare foveal and peripheral colour perception directly by a matching technique for any peripheral location. A.

535.7

Physiological optics. Vision. *See under* "Medical science. Human physiology." Decimal classification 612.84

535.8

9596. Method of measuring the contrast rendition of optical systems for line targets of various angular subtenses. H. S. Coleman, L. V. Foster and D. L. Fridge. *J. Opt. Soc. Amer.*, **45**, *No.* 10, 886–90 (*Oct.*, 1955).

A method has been developed for measuring the contrast rendition of optical systems for a square-wave line test object whose angular spacings vary from 1 sec to 129 sec in 2% increments. Another test object covers the range from 1 sec to 620 sec in 10% increments. These ranges cover the region of interest for practically all optical aids and photographic systems. Values of contrast rendition as high as 99·7% have been measured. The maximum value occurs for the coarsest target elements and degrades smoothly to zero at the limit of resolution. This occurs at the contrast threshold for the photomultiplier tube used as the receptor in a device referred to as the recognition contrast rendition (RCR) apparatus which is described. RCR data might be described as the frequency response to a spatial square-wave input signal. For well-corrected optical systems, changes in RCR can be measured when changes in OPD of the order of one-fortieth of a wavelength occur. In special cases, this sensitivity is maintained in the presence of as much as ten Rayleigh Limits of aberration, but in most cases the sensitivity is approximately one-twentieth of the maximum OPD in the system. Uses for RCR data include inspection, field performance evaluation, and investigation of the vision of the human observer. Since the RCR apparatus is impersonal, and the data obtained using it may be expressed numerically, it has certain advantages over visual inspection processes. Field performance evaluation of optical aids to be used for recognition tasks should be possible when nomographs for recognition are available. By making simultaneous visual and photoelectric measurements, the visual response to actual diffraction images may be compared to the measured contrast. A.

535.822.17

9597. The truth of phase-contrast images formed in commercial phase-contrast microscopes. U. Schmidt. *Ann. Phys.* [*Leipzig*] **16**, *No.* 1–2, 68–83 (1955) In German.

The intensity distribution in the image of a rectangular object is calculated for commercial microscopes having annular phase plates. Optimum values of retardation and size of annulus are deduced and confirmed by experimental measurements of intensity distributions. R. W. Fish

HEAT 536

536.2.01

9598. Thermal conductivity of real gases. F. Waelbroeck, S. Lafleur and I. Prigogine. *Physica*, **21**, *No.* 8, 667–75 (*Aug.*, 1955) In French.

In a real gas, and in the presence of a temperature gradient, the relative concentrations of the clusters vary from point to point; this leads to a diffusion of the larger clusters towards the warm regions, and of the smaller clusters and single particles towards the cold parts of the apparatus, where they respectively dissociate or recombine with the absorption or liberation of the heat of association. The increase in the thermal conductivity of the gas resulting from this "circulation" of the heat of formation of the clusters can be evaluated with reasonable accuracy at low pressures, where only monomers and dimers need to be taken into account. This effect is negligible at "high" temperatures (above the Boyle point), where the variation of the thermal conductivity λ with pressure can be represented to a high degree of accuracy by Enskog's hard sphere theory; it increases with decreasing temperature, and becomes approximately equal to the Enskog effect in the neighbourhood of the critical temperature; it is evaluated that in the case of argon, the increase is of the order of 6% atm^{-1} at the boiling point. At higher pressures, the larger clusters, which carry an important heat of formation, can no longer be neglected; as an exact calculation is difficult, some simplified models are briefly discussed. The corresponding excess thermal conductivity, for homopolar molecules, is largely due to clusters with internal cyclic links. A.

536.2.02

9599. Transient heat conduction in multiphase media. J. H. WEINER. *Brit. J. appl. Phys.*, **6**, *No.* 10, 361–3 (*Oct.*, 1955).

An analytical solution is obtained for the problem of a semi-infinite mass of material initially at a uniform temperature, the surface of which is maintained at a different constant temperature, where the material may change phase an arbitrary number of times in passing from its initial to its final temperature. Each phase of the material may have distinct thermal properties. Each change of phase is assumed to take place at a given temperature and may be accompanied by the evolution or absorption of heat. The solution is obtained by a semi-inverse procedure. A numerical example is given of the application of the solution to the analysis of the solidification of 0·2% carbon steel and comparison is made between the theoretical solution, experimental results and an electrical analogue solution of the same problem. A.

536.2.083

9600. A simple apparatus for the determination of the thermal conductivity of crystals. R. SRINIVASAN. *J. Indian Inst. Sci. A*, **37**, *No.* 3, 200–14 (*July*, 1955).

Measurements are made at room temperatures. The accuracy claimed is 3% and the apparatus has been successfully used over a range of conductivity values from 4×10^{-4} to 4×10^{-2} cal/cm. deg. sec. The measurements on a few crystals are reported. A.

536.23

9601. Thermal conductivities of organic vapor mixtures. L. A. BENNETT AND R. G. VINES. *J. chem. Phys.*, **23**, *No.* 9, 1587–91 (*Sept.*, 1955).

The thermal conductivities of binary mixtures of organic vapours have been investigated in the temperature range 60–125°C. When nonpolar vapours of similar viscosity and molecular weight are used, the variation of conductivity with composition of the mixture is roughly linear. Mixtures of nonpolar and strongly polar vapours, on the other hand, exhibit pronounced maxima in the conductivity *v.* composition curves. The difference in behaviour is due to the strong interaction between polar molecules on collision. A.

536.23 : 537.523.5 : 537.562

9602. On the theory of the thermal conductivity of plasmas. H. SCHIRMER. *Z. Phys.*, **142**, *No.* 2, 116–26 (1955) In German.

A theoretical treatment, considering the various terms that may contribute to the heat losses from a plasma (e.g. an arc channel). Electron conduction and diffusion effects are treated in detail and the influence of the difference between gas and electron temperatures is also discussed. J. D. CRAGGS

536.24

9603. On the theory of heat exchange on boiling in pipes. L. S. STERMAN. *Zh. tekh. Fiz.*, **24**, *No.* 2, 250–7 (1954) In Russian.

A system of differential equations is given which describe, in hydraulic form, the heat exchange on boiling in pipes. A general functional relation is established between criteria of similarity. On the basis of the results obtained, an analysis is given of certain relations and criteria previously established by other investigators. J. B. SYKES

536.252

9604. Laminar free convection between heat-producing vertical plates in a liquid. D. V. WORDSWORTH. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. E/R* 1270, 10 *pp.* (1955).

An analysis has been made of heat transfer by natural convection between vertical plates which are producing heat, when the flow between them is laminar. The plates are supposed to be two of a large battery of similar plates, and the whole is supposed to be immersed in a large bath of the liquid coolant. Expressions are found for coolant and plate surface temperature and coolant velocity. It is shown that velocities and temperatures depend upon the value of a parameter λ, which is itself a function of the fluid and plate properties and the heat production rate. There is only one value of λ which fulfils all the required conditions, mainly that of laminar flow, and it is suggested that other apparent values are invalid. A numerical example is included, the results of which show only small changes in plate surface temperature from bottom to top, with large changes in fluid temperature from mid-gap to plate surface. A.

536.413

9605. Thermal expansion of boric acid. M. A. LONAPPAN. *Proc. Indian Acad. Sci. A*, **42**, *No.* 1, 10–21 (*July*, 1955).

The principal coefficients of expansion and the orientation of the ellipsoid of expansion have been determined for orthoboric acid, a triclinic crystal, for the range of temperatures 30 to 80°C by an X-ray method. The anisotropy of expansion is extremely large, the maximum expansion being 256 and the minimum -4, $\times10^{-6}$. The direction of the maximum expansion coefficient is close to the *c* plane, to which all the O_3 groups are closely parallel. The occurrence of a negative expansion is a special feature of this crystal, the direction of which is found to be parallel to the shortest hydrogen bonds. This is the first time that the thermal expansion of a triclinic crystal has been fully studied by an X-ray method. A.

536.413

9606. The thermal expansion of calcite from room temperature up to 400°C. R. SRINIVASAN. *Proc. Indian Acad. Sci. A*, **42**, *No.* 2, 81–5 (*Aug.*, 1955).

The thermal expansion of calcite along and perpendicular to the optic axis were measured from room temperature up to 400°C, $\alpha_{\parallel}$ increased with increasing temperature, while $\alpha_{\perp}$, which is negative, decreases in magnitude with increasing temperatures. The high-temperature curves join up well with the low-temperature curves of Adenstadt. The Gruneisen constant is shown to vary with temperature in the usual manner. Its small value points to a valence type of binding in the crystal—a fact supported by the intense Raman effect and dielectric polarizability of calcite. A.

536.413 : 548.736.4

9607. Thermal expansion of potassium nitrate. M. A. LONAPPAN. *Proc. Indian Acad. Sci. A*, **41**, *No.* 6, 239–44 (*June*, 1955).

The principal coefficients of expansion have been

determined for the orthorhombic crystal potassium nitrate for the range of temperature 30 to 100°C by an X-ray method. The values are α_{11} $(b) = 22{\cdot}0$; α_{22} $(a) = 23{\cdot}5$; α_{33} $(c) = 182{\cdot}6 \times 10^{-6}$. The direction of the greatest expansion is perpendicular to the plane of the O_3 group and the expansion is nearly constant for all directions in the plane of the O_3 group. The approximate validity of the Grüneisen relation is tested by calculating the compressibility from a knowledge of the variation of the Raman frequency with temperature. A.

536.421.4

9608. Simplified apparatus and procedure for freezing-point determinations upon small volumes of fluid. J. A. Ramsay and R. H. J. Brown. *J. sci. Instrum.*, **32**, *No.* 10, 372–5 (*Oct.*, 1955).

For purposes of determining the freezing-point of small volumes of aqueous solutions the difficulties of undercooling are avoided by first freezing the sample and then determining the thawing-point. Apparatus and procedure specially designed for simplicity of construction and operation are described. The method works best with volumes of the order of 10^{-3} to 10^{-4} mm^3 and its accuracy in terms of standard deviation is $\pm 0{\cdot}003$ deg. C for freezing-point depressions of the order of 1 to 2 deg. C. A.

536.423.15

9609. The saturated vapour pressure of ethylene at low temperatures and the magnitude of thermomolecular pressure differences in tubes of various diameters. B. A. J. Lister and L. A. McDonald. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. C/R* 1122, 7 *pp.* (1955).

The saturated vapour pressure of ethylene has been measured under conditions where corrections for thermomolecular pressure difference can be accurately calculated. Good agreement is found with values obtained by earlier mass spectrometric observations. Experiments have been made to determine the magnitude of the thermomolecular pressure difference using tubes of different diameters at the surface of the cooling bath. A.

536.424 : 548.7

9610. The transition points of crystals of nickel nitrate hexahydrate. J. Jaffray and N. Rodier. *J. Rech. Cent. Nat. Rech. Sci.*, **6**, 252–5 (*June*, 1955) In French.

Evidence from differential thermal analysis, dilatometry, specific heat measurements and X-ray analysis show that there are five transitions below 0°C; three second-order transitions at 150°K, 169°K and 206°K, and two polymorphic transitions at 242°K and 263°K.

A. R. STOKES

536.46 : 535.333

9611. Studies of chlorine trifluoride flames. G. Skirrow and H. G. Wolfhard. *Proc. Roy. Soc. A*, **232**, 78–87 (*Oct.* 11, 1955).

Diffusion flames are described in which the fuels, hydrogen, carbon monoxide, carbon disulphide, water, ammonia, hydrocarbons and organic halides are burnt with chlorine trifluoride. Chemical equilibrium is almost complete in the main reaction zone as in oxygen diffusion flames, but the chlorine trifluoride flames possess several unusual features. Carbon formation is very pronounced with hydrocarbon fuels. Radicals such as C_2 and CN have a large partial pressure in mixed hydrogen + hydrocarbon/chlorine trifluoride flames, and their presence in a high-temperature region enhances the luminosity of the flames. It is suggested that the persistence of these radicals may be due to the very rapid diffusion of hydrogen into the main reaction zone which effectively prevents the penetration of fluorine to the fuel side of the flame. Chlorine trifluoride flames are briefly compared with fluorine flames. A.

536.48

9612. Progress in low temperature physics. Edited by C. J. Gorter. *Amsterdam: North-Holland Publishing Company* (1955) xii + 418 *pp.* [*Series in Physics*].

Review in *Nature* [*London*] **176**, 322 (*Aug.* 20, 1955). "Nearly all the articles are reviews of already published work; but R. P. Feynman's article on the application of quantum mechanics to the liquid-helium problem deserves special mention as being not so much a review as an original contribution, in which he presents important new developments of his recent ideas, in a form assimilable by the experimental physicist. These new ideas stress the importance of turbulence in the flow of liquid helium and are particularly suggestive for new experiments. The eighteen articles cover a wide variety of subjects; about half are concerned with the properties of liquid helium and superconductors, and the remainder deal with paramagnetism, antiferromagnetism, ferromagnetism, propagation of sound, and transport properties of gases."

536.48

9613. Dipole fields and the helium film. N. G. McCrum and J. C. Eisenstein. Letter in *Phys. Rev.*, **99**, *No.* 4, 1326–7 (*Aug.* 15, 1955).

In view of the fact that the properties of helium films depend in an irregular way upon the properties of the adsorbing surface, the authors discuss the effect of atomic and molecular electric fields on the thickness of the film. They suggest that experiments with macroscopic electrostatic fields would elucidate the properties of the film–surface system.

R. EISENSCHITZ

536.48

9614. Andronikashvilli disk measurements in liquid helium-3—helium-4 mixtures. J. R. Pellam. Letter in *Phys. Rev.*, **99**, *No.* 4, 1327–8 (*Aug.* 15, 1955).

Apparatus consists of a 15-disk assembly of 4 mm radius and 0·19 mm spacing immersed in $\frac{3}{4}$ cm^3 of liquid, a 3·3 mass percent solution of He^3 in He^4. By measurements between the λ-point and 0·95°K the concentration of the normal component is obtained as a function of temperature. Results without and with corrections are shown in a graph. The slope of the curve tends to vanish at 1°. The author regards it as plausible that the curve continues to fall from approx 0·1 at 1° to the theoretical value according to Feynman at absolute zero which is 0·066, i.e. double the mass concentration of He^3.

R. EISENSCHITZ

536.483

9615. Cryostat for cyclotron irradiation at liquid helium temperatures. D. E. Mapother and F. E. L. Witt. *Rev. sci. Instrum.*, **26**, *No.* 9, 843–6 (*Sept.*, 1955).

A description is given of a cryostat which has been developed for cooling small specimens with liquid helium while they are subjected to irradiations of several days duration in a cyclotron beam. The cryostat is fabricated for the most part from commercially available sheet-metal parts and consists essentially of a liquid helium vessel shielded by a liquid nitrogen cooled envelope. The intrinsic loss rates for refrigerants with this apparatus are about 5 litres per day of liquid nitrogen and 600 cm^3 of liquid helium per day, but considerably larger when the cyclotron beam is on. The performance during irradiation experiments is discussed. A.

536.49 : 539.384

9616. Thermal buckling of a rod heat source in a tubular coolant duct. C. E. Iliffe. *J. nuclear Energy*, **2**, *No.* 1, 1–14 (*Aug.*, 1955).

An analysis is made of the bending of a rod heat source in a tubular coolant duct due to any initial bend in the rod and to the irregular thermal effects such bending produces. For the case in which the mean clearance of the rod in the duct is sufficiently high, the analysis can be simplified to express the maximum bend in terms of a single parameter, B, the "thermal buckling factor." At a critical value of B the rod is shown to buckle without limit. A.

536.631

9617. Results of investigations at low temperatures. XIV. Atomic and electron heat of rhodium and iridium between 10° and 273°K. K. Clusius and C. G. Losa. *Z. Naturforsch.*, **10a**, *No.* 7, 545–51 (1955) In German.

For Pt X, see Abstr. 6014 (1953). For both metals there have been found below 14°K high values of the electron heat, characteristic of the transition metallic elements. Consequently, the atomic heats for both metals ($c_{lattice} = c_v - c_{el}$) can be represented by means of the characteristic Debye temperatures (θ_D) only in the temp. range about 50°K. F. LACHMAN

536.631 : 541.113

The atomic heat of sodium. *See Abstr.* 10023

536.631 : 538.222

9618. Interaction effects in some paramagnetic salts. R. J. Benzie, A. H. Cooke and S. Whitley. *Proc. Roy. Soc. A*, **232**, 277–89 (*Oct.* 25, 1955).

Measurements have been made of the magnetic contributions to the specific heats of several paramagnetic salts, and of diluted specimens consisting of mixed crystals of the same paramagnetic salts with isomorphous diamagnetic salts. It is shown that the specific heats can be analysed into a contribution characteristic of the isolated paramagnetic ions, due to the splitting of the ground state by nuclear and Stark effects, and a contribution due to interactions between the magnetic ions. While the specific heats of the isolated ions agree well with the values calculated from paramagnetic resonance data, the interaction contributions are in several cases too large to be accounted for by magnetic dipole interaction between the ions. It is concluded that exchange interaction is important, even in magnetically very dilute salts, and that it is predominantly of the anisotropic type postulated by Van Vleck and Opechowski. It is shown that in some salts the Stark splitting of the ground state of the magnetic ions is very sensitive to small distortions of the crystal lattice, so that in these cases it is not possible to apply the results of measurements on diluted specimens to calculate the properties of the pure substances. A.

536.633 : 539.132

9619. Barrier height and thermodynamic functions of gaseous HNO_3 and DNO_3. A. Palm and M. Kilpatrick. Letter in *J. chem. Phys.*, **23**, *No.* 8, 1662–3 (*Aug.*, 1955).

The barrier height was used to calculate the torsional contributions to the thermodynamic functions. A table of heat content, free energy, entropy and heat capacity is given. C. TURNER

536.666 : 539.13

9620. Lattice energies of the alkaline earth imides and the heat of formation of NH^{-2}. A. P. Altshuller. Letter in *J. chem. Phys.*, **23**, *No.* 8, 1561–2 (*Aug.*, 1955).

The lattice energies of CaNH, SrNH and BaNH and the heat of formation of BaNH are used to calculate the heat of formation of NH^{-2}(g). Heats of protonation of NH^{-2}(g) to NH_2^{-1}(g) and NH_3(g) and NH_4^{+}(g) are also calculated. C. TURNER

THERMODYNAMICS 536.7/.8

536.7

9621. Quasi-stationary process. I. On entropy production. S. Fujita. *Kumamoto J. Sci. A*, **2**, *No.* 1, 51–63 (*Dec.*, 1954).

It is proved and explained by Prigogine, de Groot and Meixner that the entropy production of an irreversible process is minimum in the stationary state. The writer found, however, that there appear to be some cases where the entropy production is not minimum in the stationary state. Also he introduced a formula for the rate of change of forces in an irreversible process and thereby deduced expressions for the time-variations of forces, fluxes and entropy production in non-stationary processes. A.

536.7 : 530.162

9622. On the foundations of statistical thermodynamics. L. Rosenfeld. *Acta phys. Polon.*, **14**, *No.* 1–2, 3–39 (1955).

Surveys the logical structure of statistical thermodynamics showing how faithfully this theory reflects the peculiar dialectical character of the physical situation. The author outlines very briefly the foundations of the atomistic interpretation of the laws of thermodynamics, laying the emphasis on the physical meaning of the formal arguments. The points he makes are no doubt familiar to those who have looked into the matter; but there is still widespread confusion concerning some of them, which affords justification for taking up the question from a synthetic point of view. A.

ELECTRICITY 537

ELECTROSTATICS . DIELECTRICS 537.2

537.226

9623. Contributions of fluctuations and anisotropy to dielectric polarization in polar substances. F. E. HARRIS. *J. chem. Phys.*, **23**, *No.* 9, 1663–72 (*Sept.*, 1955).

The theory of dielectric polarization in polar substances is extended to include the effect of fluctuations in the dipole moments of the individual molecules. The effect of optical anisotropy is also taken into account. The resulting expression for the dielectric constant is identical in its leading terms to an earlier result of Harris and Alder, in which fluctuations are neglected, but differs significantly from an equation derived by Frohlich, which is here explicitly shown to involve an additional approximation. Application of the theory to gases is discussed briefly. It is pointed out that Onsager's formula for relating the permanent dipole moment of a molecule to its average moment in the dielectric involves an approximation which produces an incorrect limiting behaviour at large volumes, so that it should not be applied to polar gases at normal pressures. Calculations are presented showing the various contributions to the dielectric polarization of gaseous ammonia. The fluctuation term contributes of the order of 20% of the term expressing the correlation in orientation of the average dipole moments. The theory is also applied to liquid water, using Pople's bendable hydrogen bonded model for that substance. In water the fluctuation term is but 6% of the direct correlation term, and opposite in sign. The results are discussed briefly. A.

537.226.1

9624. The dielectric constant of an imperfect non-polar gas. A. D. BUCKINGHAM AND J. A. POPLE. *Trans Faraday Soc.*, **51**, *Pt* 8, 1029–35 (*Aug.*, 1955).

The total dielectric polarization of a gas is expanded in inverse powers of the molar volume and the first term representing deviations from perfect gas behaviour is examined in detail. Three possible effects are distinguished: (i) The polarizability of a molecule may be altered by the presence of a neighbour. (ii) There may be additional moments induced by the fields of the induced moments of neighbouring molecules. (iii) Molecules with no permanent dipoles may possess moments induced by quadrupole moments of other molecules. The two latter effects are investigated quantitatively for several non-polar substances. Calculations suggest that the third is important for quadrupolar molecules such as carbon dioxide. A.

537.226.1

9625. The theory of the dielectric constant of ionic crystals. III. J. YAMASHITA AND T. KUROSAWA. *J. Phys. Soc. Japan*, **10**, *No.* 8, 610–33 (*Aug.*, 1955).

For Pt II, see Abstr. 3707 (1955). A general theory of the dielectric constant of simple ionic crystals is proposed. The energy change due to the electric field is expressed by a quadratic form of quantities p_x, p_1 and p_2, which represent the dipole moments due to the displacement of ions, the deformation of the negative ion and the deformation of the positive ion in the electric field respectively. Using this formalism it is possible to derive several important relations concerning the dielectric properties of ionic crystals. When the polarizability of the positive ion is much smaller than that of the negative ion, it is allowable to put $p_2 = 0$. In this case the quadratic formalism has only three unknown constants, which are determined by using three observed quantities. For NaCl they are determined by using κ_0, κ and β (the optical dielectric constant, the static dielectric constant and the compressibility). The pressure effect of dielectric constants is discussed, and the Reststrahlenfrequenz of NaCl computed considering ionic polarization. The result agrees well with observation. Finally a method of determining the phenomenological repulsive potential between ions of ionic crystals is proposed. A.

537.226.1

9626. On the anomaly of the dielectric properties of *n*-higher alcohols. K. ASAI, E. YODA AND S. YAMANAKA. *J. Phys. Soc. Japan*, **10**, *No.* 8, 634–42 (*Aug.*, 1955).

The cause of the abnormally high value of the dielectric constant of *n*-higher alcohols was investigated on the basis of some experimental results. To begin with, the discrepancies between d.c. and a.c. conductivity were examined in order to clarify the behaviour of the net conduction-current and the absorption-current due to dipole rotation. Next, the frequency dependency of the dielectric constant in the low frequency region (30 c/s ~ 5 kc/s) was observed and the results were discussed in connection with Maxwell–Wagner's formula on the composite dielectric and with Cole's theory on the conductive dielectric. Thus, it seems to be reasonable to think that the high value of the dielectric constant of *n*-higher alcohols is an apparent value due to the higher electrical conductivity of its molecular rotating phase. An idea for the mechanism of the proton transfer in the solid alcohol is presented. A.

537.226.1

9627. The permittivity of two phase mixtures. C. A. R. PEARCE. *Brit. J. appl. Phys.*, **6**, *No.* 10, 358–61 (*Oct.*, 1955).

Compares the results of a number of workers with the predictions of published formulae. It is shown that expressions due to Bruggeman accord with the observations but those due to Böttcher, and Van Vessem and Bijvoet are only valid over a limited range of permittivities. An empirical expression is given which is adequate for all available relevant results. A.

537.226.1.08

9628. Measurement of ϵ' and tan δ of a solid dielectric in the cm-wave range in the temperature interval −100 to +100°C. P. F. VESELOVSKIĬ. *Zh. tekh. Fiz.*, **25**, *No.* 4, 601–9 (1955) In Russian.

A new method of measuring ϵ' and tan δ of a solid dielectric at $\lambda_0 = 3{\cdot}17$ cm between −100 and +100°C is presented. It uses a rectangular resonator designed for H_{10} oscillations and a method of contact-less interconnection of the waveguide sections. The lower section is placed in a vacuum vessel to prevent condensation of vapour on it. The calculation of the resonator is explained and the theory of the measurements evolved. ELECTRICAL RESEARCH ASSOCIATION

537.226.1.08

9629. Microwave dielectric measurements. II. 8,700 to 9,700 Mc/s range. S. S. Srivastava, C. S. Rangan and M. M. Sahai. *J. sci. industr. Res.*, **14B**, *No.* 7, 315–20 (*July*, 1955).

For Pt I, see Abstr. 9227 (1954). Resonant cavities have been constructed in the 3 cm region to measure the dielectric constant and the dielectric loss of solids and liquids. The construction of the equipment is described and methods of mode identification and suppression are considered. Measurements on several dielectrics have been carried out to assess the performance of the equipment. Dielectric constant and tan δ values for several oils and fatty acids are reported. A.

537.226.2

9630. Dielectric properties of ice at very low frequencies and the effect of prestressing. H. Gränicher, C. Jaccard, P. Scherrer and A. Steinemann. *Helv. phys. Acta.*, **28**, *No.* 4, 300–3 (1955) In German.

In pure ice crystals at $-10°C$, a new Debye dispersion region is found at very low frequencies ($\sim 0{\cdot}7$ c/s). The dispersion region is displaced to higher frequencies by the introduction of defects. Prestressing does not effect the permittivity of pure crystals, but in crystals with defects low frequency dispersion disappears after prestressing. The results are explained by Macdonald's theory of space charge polarization effects. [Abstr. 457 (1954).] J. H. MASON

537.226.2 : 535.376

9631. The electrical properties of electroluminescent phosphors. A. N. Ince and C. W. Oatley. *Phil. Mag.*, **46**, 1081–103 (*Oct.*, 1955).

Measurements have been made of the dielectric properties of a number of electroluminescent phosphors in the form of powders and polycrystalline lumps. There appear to be two quite separate mechanisms giving rise to dispersion: one which is present in the dark and the other which is stimulated by irradiating the phosphor with ultraviolet light. The latter is very similar to the dispersion found in ordinary non-electroluminescent powders and has not been studied further. The former, which seems to be characteristic of electroluminescent phosphors, produces dispersion at very low frequencies and has been investigated in detail. Measurements have also been made of the variation of dielectric properties with voltage and with temperature. To explain the effects observed it is assumed that electronic barriers are formed in the specimen and that motion of some of the ions in the barrier region takes place. On the basis of this model it is found possible to account in a semi-quantitative manner for the experimental results. Values are deduced for the height of the barrier and for the number and diffusion coefficient of the mobile ions. A.

537.226.2

9632. Antiferroelectricity of deuterium diammonium orthoperiodate. D. Aboav, H. Gränicher and W. Petter. *Helv. phys. Acta*, **28**, *No.* 4, 299–300 (1955) In German.

The preparation of $(ND_4)_2D_3IO_6$ is briefly described. Permittivity measurements show a transition at $-7°C$ similar to that in $(NH_4)_2H_3IO_6$ at $-22°C$ [cf. Baertschi, Abstr. 773 (1946)]. J. H. MASON

537.226.5 : 621.315.616.96

9633. Investigation of the dielectric losses of polyethylene. G. P. Mikhaĭlov, S. P. Kabin and B. I. Sazhin, *Zh. tekh. Fiz.*, **25**, *No.* 4, 590–4 (1955) In Russian.

Three types of dielectric relaxation losses occur in polyethylene, characterized by the following most likely relaxation times: $\tau_1 = 10^{-9}$ sec (h.f.), $\tau_2 = 10^{-5}$ sec (m.f.), $\tau_3 = 10^{-2}$ sec (l.f.). This is explained by the partly crystalline structure of the material. The losses themselves are due to the presence of polar radicals C=O in the molecule. After thermal treatment the absolute loss figures increase without appreciable change of the temperature and frequency relations of tan δ. ELECTRICAL RESEARCH ASSOCIATION

537.226.8

9634. The effect of mechanical stress on dielectric breakdown of alkali-halide single crystals. Y. Inuishi and T. Suita. Note in *J. Phys. Soc. Japan*, **10**, *No.* 7, 588–9 (*July*, 1955).

The average d.c. and impulse electric strengths of annealed KCl crystals increase when moderate mechanical stress is applied, but decrease at higher stresses. Electric strength values with d.c. are greater than with impulses of $0{\cdot}2 \times 1\,000\,\mu$sec; possibly due to space charge effects. J. H. MASON

537.226.8

9635. Effects of mechanical stress on dielectric breakdown of alkali-halides. II. Time effect. Y. Inuishi and T. Suita. Note in *J. Phys. Soc. Japan*, **10**, *No.* 7, 590–1 (*July*, 1955).

The d.c. electric strength of KCl crystals increases when mechanical stress is first applied, but the effect decreases after a few minutes. J. H. MASON

537.226.8

9636. Effect of interfacial conductivity on dielectric properties. C. T. O'Konski. Letter in *J. chem. Phys.*, **23**, *No.* 8, 1559 (*Aug.*, 1955).

A dilute random suspension of spheres of radius R and permittivity ϵ_2 in a medium of permittivity ϵ_1, having interfacial surface conductivity λ is shown to exhibit Debye type dispersion. The relaxation time is proportional to R/λ, so that λ can be determined from dielectric dispersion studies on uniform suspensions. J. H. MASON

537.226.8

9637. On the theory of dielectric breakdown in ionic crystals. II. B. V. Paranjape. *Rep. Brit. Elect. Res. Assoc., Ref. L/T285*, 8 *pp.* (1953).

For previous part, see Abstr. 2396 (1954), which reports the application by Fröhlich to pure crystals of the method of calculating the breakdown strength previously developed for amorphous substances. In this method the electrons are considered to be in thermal equilibrium at a temperature higher than the lattice temperature. These ideas have been carried through in a more accurate way. The results obtained agree satisfactorily with experiments. A.

537.226.8 : 548.7

9638. An experimental contribution to the problem of dielectric breakdown in single crystals of CdS. K. W. Böer and U. Kümmel. *Ann. Phys.* [*Leipzig*] **16**, *No.* 3–4, 181–91 (1955) In German.

An experimental study is made of the relation

between "electrical" and thermal glow curves for a CdS crystal. Correlation is found for fields less than one-half the breakdown value but above this the correlation breaks down and there is strong disturbance of defect levels by the relatively large current flow. G. F. J. GARLICK

537.228.1

9639. Calculation of the frequency of oscillation of a quartz [vibrator] maintained by a transistor. G. BRIFFOD. *C.R. Acad. Sci.* [*Paris*] **241,** *No.* 2, 159–61 (*July* 11, 1955) In French.

The earlier calculation [Abstr. 4634 (1955)] is generalized to indicate the effect of the driving system on the frequency and the possibility of adjusting the frequency to match it against a reference signal.

W. BARDSLEY

537.228.1

9640. Anisotropy of polarized polycrystalline barium titanate. D. S. MOSELEY. *J. Acoust. Soc. Amer.*, **27,** *No.* 5, 947–51 (*Sept.*, 1955).

Square bars of polycrystalline barium titanate ceramic have been prepolarized and their lowest longitudinal resonance excited piezoelectrically on remanent polarization. Bars were prepared as twins in every way, except that one twin was electroded on its ends, the other on a pair of opposite sides. The first polarization applied was that minimum (800 V/cm for 30 minutes at 27°c) which fixed any electromechanical activity as detected by a sensitive a.c. bridge, and this was taken to approximate the unpolarized, isotropic state ($s_{11} = s_{33}$). Different pairs were then given different large-scale polarizations (2·5, 5·0 and 10 kV/cm cooled from above the Curie point) and changes noted. All resonant frequencies rose with time, the decay constant being between 0·01 and 0·02 hr^{-1}, and the total change being 1 to 1½% for "Ceramic A" (barium titanate), and ½% for "Ceramic B" (barium calcium titanate). For both materials the isotropic compliance was definitely much closer to s_{33}^E than to s_{33}^D, and averaged closer to s_{11}^E than to s_{11}^D. The ratios $s_{33} : s_{11}$ were 0·83 and 0·87 at constant D and 1·04 and 1·05 at constant E for the two materials after 10 kV/cm. Anisotropy varied somewhat with polarizing field strength. A.

537.228.1 : 621.372.412

9641. Dynamic measurements on piezoelectric resonators with very large electromechanical coupling. H. E. MÜSER AND H. BITTEL. *Arch. elekt. Übertragung*, **9,** *No.* 5, 231–6 (*May*, 1955) In German.

Crystal measurements are usually made with an equivalent circuit in mind. When the electromechanical coupling coefficient is high, however, the parallel and series resonances are widely separated and the simple representation no longer applies. This is the case, e.g. for ferroelectric crystals in longitudinal vibration at the Curie point. The complete (i.e. multi-mode) equivalent circuit must be used. This circuit is particularly significant because the contributions of its individual branches to the piezoelectric current correspond to the coefficients of a Fourier representation of the oscillatory mode. Experimental results on a 53 kc/s crystal are reported. These take the form of plots of current density v. distance along the crystal and enable the vibration profile to be deduced. S. C. DUNN

537.29 : 541.12 : 537.226.8

9642. On chemical change of *n*-higher alcohol caused by the influence of strong electric field. K. ASAI. Note in *J. Phys. Soc. Japan*, **10,** *No.* 8, 716–18 (*Aug.*, 1955).

The alteration of the temperature-dependence curve of the dielectric constant of octadecyl alcohol brought about by the application to the alcohol for varying times of intense electric fields is explained as being due to chemical changes. The production of aldehyde is indicated by the fuchsin test. W. GOOD

ELECTRIC CONDUCTION . CURRENTS 537.3

537.3

9643. Simply constructed ampere balance with good precision. R. L. EDWARDS. *Amer. J. Phys.*, **23,** *No.* 7, 413–14 (*Oct.*, 1955).

Although the ampere balance is today the primary standardizing device for the measurement of electric current, such balances are not available in the laboratory supply houses. This paper describes the construction of a simple balance well suited for quantitative laboratory work as well as class room demonstration. A.

537.311.3

9644. On the resistance variation of transparent amorphous films of nickel with the absorption of hydrogen. R. SUHRMANN AND K. SCHULZ. Note in *Naturwissenschaften*, **42,** *No.* 11, 340 (1955) In German.

The absorption of hydrogen causes an increase in film resistance and the effect is opposite in sense to that observed with crystalline Ni films.

C. A. HOGARTH

537.311.31 : 539.231

9645. A study of transparent, highly conducting gold films. E. J. GILLHAM, J. S. PRESTON AND B. E. WILLIAMS. *Phil. Mag.*, **46,** 1051–68 (*Oct.*, 1955).

Thin gold films deposited on a substrate of bismuth oxide or, better, between two films of bismuth oxide, are found to have exceptionally high electrical conductivity and optical transmission. Heating to several hundred degrees centrigrade further enhances these properties, irreversibly. Typical results, for gold thickness 100 Å and heat-treatment at 450°c, are film-resistance 3½ ohms "per square" and white-light transmission 75% (or 82% using controlled interference effects). The measured electrical and optical constants are remarkably close to those of gold in bulk. This appears to be due to a very fine-grain, continuous structure. Electron microscopy and diffraction show that even at 60 Å thickness no holes of resolvable size exist in the film, that the lateral dimension of the gold particles is some ten times the film thickness, and that the enclosing bismuth oxide films are amorphous, at least initially. The effect of the heating appears to include a considerable reduction in internal surface and also a marked reduction in surface-roughness. Surface reflection of conduction-electrons is found to change from fully diffuse to almost fully specular, as a result of the heating. The

function of the bismuth oxide seems to be to preserve, up to quite high temperatures, surface energy conditions controlling mobility of grains, and opposing increase in gold surface area. This would account for the absence of aggregation during deposition, and of grain-growth perpendicular to the surface during heating which would otherwise disrupt the films at much lower temperatures. In this respect, and possibly also in promoting a smooth gold surface, the oxide enclosure seems to simulate one of gold itself. The films have a possible use as transparent conducting coatings, for the purpose of de-icing aircraft windows by direct electrical heating. A.

537.311.31 : 539.234

9646. On the changes on tempering of the temperature dependence of resistivity of evaporated films of pure bismuth, bismuth-antimony and bismuth-tellurium alloys. R. SUHRMANN AND H.-G. WUTTKE. *Z. Elektrochem.*, **59,** *No.* 5, 379–99 (1955) In German.

The resistance of Bi films evaporated at 90°K passes irreversibly through a maximum as the tempering temperature is raised. After tempering at high temperatures Bi shows impurity conduction at low temperature. Disordered Bi atoms act as acceptors. Thinner films, $<15\,m\mu$, show no resistance maximum and are impurity conductors at all temperatures. Te additions decrease the resistivity and decrease the band separation at high temperatures. For Te additions of about 0·6% and high temperature tempering metallic conduction with overlapping bands is seen. Similar investigations on small Sb additions are reported. W. M. LOMER

537.311.32 : 548.7

9647. Electrical conductance mechanisms in solid caesium halides. W. W. HARPUR, R. L. MOSS AND A. R. UBBELOHDE. *Proc. Roy. Soc. A*, **232,** 196–207 (*Oct.* 25, 1955).

Electrical d.c. conductances of caesium halides as ordinarily obtained are found to be anomalous compared with the halides of the other alkali metals: (i) In the conventional relationship, $\log\sigma = \log\sigma_0 - E/RT$ (conductance σ, temperature T°K), the values both of σ_0 and of the activation energy E are abnormally low for all the caesium halides, compared with the other alkali halides. (ii) In the neighbourhood of the transition b.c.c. → f.c.c. in caesium chloride at 469°C, no rise of conductance is observed, contrary to what might be expected on structural grounds if the conductance is ionic and the lattice shows premonitory break-up on approaching the transition. E is much the same for both polymorphs, but σ_0 for the f.c.c. lattice is about one-fiftieth that for the b.c.c. lattice. (iii) Transport measurements show that much of the current flows through caesium chloride without an accompanying transport of matter. The simplest interpretation of all these anomalies is that an important part of the conductance of the caesium halides as ordinarily obtained is electronic, not ionic. Possible reasons are discussed. A.

537.311.33

9648. The validity of the hydrogen-like approximation for impurity levels. G. RICKAYZEN. *J. Electronics*, **1,** *No.* 2, 122–5 (*Sept.*, 1955).

The potential energy of an electron trapped in an impurity level includes the dielectric constant κ for the medium. The adequacy of κ as an accurate description of local polarization in absence of the electron is questioned. A further problem is the effect of the electron on the surrounding medium. It is concluded that the hydrogen-like approximation is valid in many practical cases particularly in covalent solids. G. F. J. GARLICK

537.311.33

9649. A simple method to visualize degeneracy of an intrinsic semi-conductor. G. BUSCH. *J. Electronics*, **1,** *No.* 2, 178–80 (*Sept.*, 1955).

A nomographical method of solution for a range of effective mass ratios of electrons to holes, and a range of ratios kT/forbidden energy gap shows up degeneracy in a usual way in a deviation from the straight line region of the log plot of the Fermi integral $F_{\frac{1}{2}}$. F. ANSBACHER

537.311.33 : 541.57

9650. Bond relationships in diamond-type semiconductors. C. H. L. GOODMAN. *J. Electronics*, **1,** *No.* 2, 115–21 (*Sept.*, 1955).

The effect of the relative amounts of covalent and ionic binding on the energy gap for binary semiconductors is discussed. Presence of ionic binding will increase the filled band-conduction band gap. It is possible to obtain the degree of ionic binding from the variation of energy gap with bond length. A development of the discussion suggests a relation between the carrier mobility and degree of ionic binding. A small degree of ionic binding gives high mobility and low effective carrier mass.

G. F. J. GARLICK

537.311.33

9651. On the polarization of silver sulfide. S. MIYATANI. *J. Phys. Soc. Japan*, **10,** *No.* 9, 786–93 (*Sept.*, 1955).

The variation of the chemical potential of electrons in Ag_2S with the variation of the Ag/S ratio was measured with the help of the e.m.f. measurements of the galvanic cell $Ag|AgI|Ag_2S|Pt$. The relation between the chemical potential of electrons and the density of conduction electrons was found to be in accordance with the theory, and it was found that the conduction electrons in β–Ag_2S obey the classical statistics while those in α–Ag_2S are degenerate. Polarization phenomena when weak direct current of constant intensity is sent through Ag_2S specimen were also studied. The potential distributions along the specimen and the time-rate of building up or decay of polarization show good agreement with the theory in both α- and β-phases. The conductivities were measured and discussed. A.

537.311.33

9652. Preliminary study of the electrical properties of a semiconducting diamond. J. J. BROPHY. Letter in *Phys. Rev.*, **99,** *No.* 4, 1336 (*Aug.* 15, 1955).

Hall effect, resistivity and point contact rectification properties of a blue-white Type IIb diamond are briefly reported. Approximate values obtained are 7×10^{13} holes per cm^3, resistivity 760 ohm cm and hole mobility 100 cm^2 volt^{-1} sec^{-1}. The Hall slope gives an activation energy of 0·35 eV. C. A. HOGARTH

537.311.33 : 548.55

9653. Preparation and electrical properties of CdTe single crystals. F. A. KRÖGER AND D. DE NOBEL. *J. Electronics*, **1**, *No.* 2, 190–202 (*Sept.*, 1955).

Single crystals of CdTe were grown from the melt under a Cd atmosphere in a sealed silica tube. CdTe is *n*-type when the Cd content exceeds the stoichiometric proportion, and *p*-type with an excess of Te. To obtain crystals of various conductivities, samples were heated at 900°C under a range of pressures of Cd, above 0·56 atm CdTe became *n*-type. Thermoelectric measurements gave an effective mass ratio of 0·14 for electrons and 0·37 for holes. The variation of Hall coefficient with temperature is larger for *p*-type than *n*-type samples, the position of donor and acceptor levels is discussed. The mobility of electrons at room temp. is 600 $cm^2.V^{-1}.sec^{-1}$ and of holes 50 $cm^2.V^{-1}.sec^{-1}$. J. FRANKS

537.311.33

9654. A contribution to the question of thermal acceptors in germanium. Z. TROUSIL. *Czech. J. Phys.*, **5**, *No.* 3, 393–403 (*Aug.*, 1955).

The motion and decay of thermal acceptors in germanium was studied using the method of saturation and the extraction of solid germanium by means of a liquid alloy of Ge/Sn. The qualitative results obtained confirm that the production of thermal acceptors in germanium is conditioned by the presence of copper and in addition prove the applicability of this method to the solution of similar problems. A.

537.311.33 : 538.224

9655. Magnetic indications of electronic structure of the conduction band in Ge. J. H. CRAWFORD, JR, H. C. SCHWEINLER AND D. K. STEVENS. Letter in *Phys. Rev.*, **99**, *No.* 4, 1330 (*Aug.* 15, 1955).

Diamagnetic susceptibility measurements indicate that 4 rather than 8 ellipsoids best represent the energy surfaces in *k* space for *n*-type Ge. In the high temperature region a significant decrease occurs for the square of the reciprocal mass ratio tensor, averaged appropriately, with increasing electron concentrations (obtained by Hall coeff. measurements).

F. ANSBACHER

537.311.33

9656. On the degeneracy effect in InAs. R. TALLEY AND F. STERN. *J. Electronics*, **1**, *No.* 2, 186–9 (*Sept.*, 1955).

The impurity bands, calculated on the assumption of ordered hydrogenic type impurities, may overlap the bottom of the conduction band for comparatively small impurity concentrations ($1{\cdot}5\times10^{-16}$ cm^{-3}), thus explaining the difficulty of freezing out donor electrons in InSb and InAs. The calculations are compared with transmission measurements on InAs (Se doped) giving reasonable agreement for effective electronic mass ratio of 0·03 over a large range of impurity concentrations. F. ANSBACHER

537.311.33

9657. A study of the conduction band of InSb. R. BARRIE AND J. T. EDMOND. *J. Electronics*, **1**, *No.* 2, 161–70 (*Sept.*, 1955).

Measurements of optical absorption edge, thermoelectric power, Hall constant and conductivity are made on a wide range of specimens. Analysis of the results suggests that the conduction band is not parabolic. C. A. HOGARTH

537.311.33 : 538.63

9658. The magneto-resistance effect in indium antimonide. R. MANSFIELD. *J. Electronics*, **1**, *No.* 2, 175–7 (*Sept.*, 1955).

Measurements on impure specimens showed a large value for B in the expression $(\rho-\rho_0)/\rho_0 = BH^2/(1+CH^2)$ where $(\rho-\rho_0)/\rho_0$ is the relative increase in resistance and $B \simeq C$ in most cases.

C. A. HOGARTH

537.311.33

9659. Applications of indium antimonide. I. M. ROSS AND E. W. SAKER. *J. Electronics*, **1**, *No.* 2, 223–30 (*Sept.*, 1955).

Reviews applications such as photocell and filter material for the infrared, the measurement of magnetic fields, the Hall effect compass, Hall effect amplifier, Hall effect function multiplier, as a resistance gyrator and as a transducer. C. A. HOGARTH

537.311.33 : 535.343

9660. The preparation, electrical and optical properties of Mg_2Sn. W. D. LAWSON, S. NIELSEN, E. H. PUTLEY AND V. ROBERTS. *J. Electronics*, **1**, *No.* 2, 203–11 (*Sept.*, 1955).

Specimens of Mg_2Sn were prepared by melting Mg and Sn together in a sealed carbon crucible, filled with argon, and purified by zone-refining in a similar system. Optical absorption spectra were obtained over the wavelength range 2–20 μ, for specimen temperatures from 4·2°K to 294°K. The main absorption edge occurred between 3–5 μ, with a subsidiary band at 7·7 μ at the higher temperatures. Analysis of the spectra suggests that the activation energy is 0·18 eV at 294°K and 0·11 eV at 4°K. Hall effect and conductivity have been measured between 77°K and 500°K, the results giving a value of 0·35 eV for the activation energy at room temperature, and 318 and 263 cm^2/V.sec for the electron and hole mobilities respectively. D. G. AVERY

537.311.33

9661. On the inductive part of the a.c. characteristics of the semiconductor diodes. Y. KANAI. Note in *J. Phys. Soc. Japan*, **10**, *No.* 8, 719–20 (*Aug.*, 1955).

The small signal a.c. characteristics of Ge and Si junction diodes were measured from 3 kc/s to 5 Mc/s over a range of temperatures. Deviations from Shockley's theory for the forward current were observed at high frequencies and related to an inductive component of the reactance, possibly due to the conductivity modulation. C. A. HOGARTH

537.311.33

9662. Low frequency noise in illuminated germanium diodes. R. E. BURGESS. Note in *Proc. Phys. Soc. B*, **68**, *Pt* 8, 569–71 (*Aug.*, 1955).

Results of Granville and Gibson and of Slocum and Shive are explained in terms of an increase in shot noise at a given reverse voltage when the contact is illuminated. The $1/f$ component is unaffected by the illumination. C. A. HOGARTH

537.311.33

9663. Properties of selenium rectifiers with various impurity materials. F. Eckart and A. Schmidt. *Ann. Phys.* [*Leipzig*] **16**, *No.* 3–4, 134–52 (1955) In German.

The patent literature includes many "recipes" for the addition of impurities and impurity mixtures to Se during the preparation of rectifiers so as to improve the final characteristics. A systematic study of the effects of adding particular impurities is described here. It is found that fluorine and fluorine compounds have no effect and the alkali halides only a small effect on the characteristics, whereas bromine has a very marked effect. Tellurium, arsenic, thallium bromide and copper bromide have a marked effect when introduced as impurity centres. By the use of very high purity Se, excellent rectifiers can be made without doping. C. A. HOGARTH

537.311.33

9664. The reverse conductivity of alloyed Si junction diodes. A. Herlet and H. Patalong. Note in *Z. Naturforsch.*, **10a**, *No.* 7, 584–6 (1955) In German.

Alloyed Si junction diodes usually have a *p–s–n* structure (*s* indicates weak doping). Analyses of the current flow in this structure give a relation between resistivity and breakdown (avalanche) voltage which fits experimental results well at least over a range of resistivities from 4 to 170 ohm.cm. C. A. HOGARTH

537.311.6 : 548.7

9665. A.C. impedance measurements on CdS crystals. H. Kallmann, B. Kramer and P. Mark. Letter in *Phys. Rev.*, **99**, *No.* 4, 1328 (*Aug.* 15, 1955).

Large increases in capacitances of light-irradiated condenser cells with CdS single crystals as dielectric are attributed to a fall in volume resistivity leaving 10^{-6}cm wide surface barrier capacitances. The increase is quenched by increasing the applied a.c. field (probably due to surface barrier breakdown) and by infrared light. Contributions due to trapped electrons in the crystal volume are negligible.

G. F. J. GARLICK

537.312.5

9666. GaAs photocells. R. Gremmelmaier. Note in *Z. Naturforsch.*, **10a**, *No.* 6, 501–2 (1955) In German.

A *p–n* junction cell of gallium arsenide is made from the melt giving a polycrystalline material. For 1·1 milliwatts per cm^2 of incident radiation the photovoltage is 0·66 volts and the short-circuit current 2·6 milliamp per cm^2. For sunlight of 0·1 watt per cm^2 this gives an efficiency of about 1%. A later cell gives about 4% efficiency. G. F. J. GARLICK

537.312.5

9667. New photoemissive cathodes of high sensitivity. A. H. Sommer. Letter in *Rev. sci. Instrum.*, **26**, *No.* 7, 725–6 (*July*, 1955).

Cathodes consisting of Sb and more than one alkali metal are much more sensitive to 2870°K W light than Sb plus one alkali metal. Sb–K–Na and Sb–K–Na–Cs have been studied in detail at 2870°K. S–K–Na yield is 50 μA/lumen and Sb–K–Na–Cs is 180 μA/lumen. The increase is primarily in the long-wave region. In contrast to Sb–Cs, oxygen reduces the sensitivity of the new cathodes.

A. H. W. BECK

537.312.5

9668. Mobility and quantum yield of charge carriers in crystal violet. R. C. Nelson. Letter in *J. chem. Phys.*, **23**, *No.* 8, 1550 (*Aug.*, 1955).

See Abstr. 7439–41 (1954).

537.312.5

9669. Preparation of photoconductive films of cadmium sulphide. R. C. Nelson. Letter in *J. Opt. Soc. Amer.*, **45**, *No.* 9, 774–5 (*Sept.*, 1955).

Analysis of cadmium sulphide precipitates used for evaporation reveals considerable chlorine and metal contents. Prolonged washing leaves a residual impurity, probably cadmous chloride, which can act as a donor impurity. G. F. J. GARLICK

537.312.5 : 537.311.33

9670. The thermodynamics of non-barrier layer photovoltaic phenomena. J. Tauc. *Czech. J. Phys.*, **5**, *No.* 3, 300–4 (*Aug.*, 1955).

By using quasi-Fermi levels introduced by Shockley, which have the meaning of partial chemical potentials of an assembly of electrons and an assembly of holes, and an analogy with galvanic cells, an equation was derived for the photovoltage of a non-barrier-layer semiconductor photocell on the basis of thermodynamic laws. For the case that classical statistics are valid the basic equation leads to the result derived by kinetic considerations. Attention is thus drawn to the application of thermodynamics to photovoltaic phenomena in semiconductors. A.

537.312.5 : 538.63

9671. The photoelectromagnetic effect in indium antimonide. C. Hilsum, D. J. Oliver and G. Rickayzen. *J. Electronics*, **1**, *No.* 2, 134–7 (*Sept.*, 1955).

The measurement of the photoelectromagnetic (PEM) and photoconductive effects yields values of lifetime and surface recombination velocity. The PEM effect provides a useful way of using InSb as a photosensitive cell. C. A. HOGARTH

537.312.5 : 548.736.3

Stacking faults and photoconductivity of ZnS crystals. *See Abstr.* 10092

537.312.5 : 621.383.4

9672. Large area high-current photoconductive cells using cadmium sulfide powder. F. H. Nicoll and B. Kazan. *J. Opt. Soc. Amer.*, **45**, *No.* 8, 647–50 (*Aug.*, 1955).

Large area high-current photocells have been made using sensitive photoconductive CdS powder, the CdS particles being held together with plastic on a supporting surface. The electrodes may either be in the form of an interdigital pattern on the insulating surface which supports the layer, or they may consist of conducting surfaces on opposite sides of the layer. In the latter case the transparent conductive coating of the glass plate on which the layer is supported serves as one electrode. In practice, the CdS powder can be applied to a surface by conventional techniques such as spraying or silk screening, or by mechanically spreading. Since such photoconductive cells can be fabricated in almost any size and since the powder is capable of a photosensitivity of approximately one ampere per lumen, cells can readily be made capable of carrying photocurrents of an ampere or more in

room light. Cells made with present powders have time constants of buildup and decay of the order of 0·1 sec. Devices of this type are thus ideally suited for operating relays or directly controlling, over a continuous range, high-current devices such as incandescent light bulbs or motors. A.

537.312.62 : 539.11 : 534.23

Ultrasonic attenuation in superconducting metals. *See Abstr.* 9499

537.32

9673. Thermoelectric applications of semiconductors. H. J. GOLDSMID. *J. Electronics*, **1**, *No.* 2, 218–22 (*Sept.*, 1955).

A review of the theory of thermoelectric generators and refrigerators suggests that materials of high mean atomic weight should be used, provided that the effective mass of the free charge carriers is reasonably high. Results of cooling experiments using Bi_2Te_3 are described and a photograph of a *p–n* Bi_2Te_3 couple capable of 40°c cooling is given. C. A. HOGARTH

537.322 : 536.7

9674. Thermoelectric effect in electrolytes. I. Thermodynamical investigation. C. MOREAU AND G. LEPOUTRE. *J. Chim. phys.*, **52**, *No.* 6, 498–502 (*June*, 1955) In French.

A complete thermodynamical treatment, starting with thermostatics, of irreversible phenomena occurring in a system which consists of two identical reversible electrodes maintained at different temperatures and immersed in a solution containing several kinds of ions. Different transport values (transference numbers of the solvent, transported entropy and heat) are defined and explained. The results obtained are applied to express some thermoelectric phenomena (Peltier effect, Thomson effect).

F. LACHMAN

ELECTRIC DISCHARGES 537.52

537.521 : 537.523.5 : 537.525.5 : 537.527.5

9675. An approximate integration of the Elenbaas–Heller differential equation. G. SCHMITZ AND K. SCHICK. Note in *Z. Naturforsch.*, **10a**, *No.* 6, 495 (1955) In German.

A brief mathematical treatment of the Elenbaas–Heller energy-balance equation for a wall-stabilized arc column. An approximate solution is given.

J. D. CRAGGS

537.521.7 : 621.316.933.1

9676. A thermally triggered spark gap. T. E. BROADBENT AND J. K. WOOD. *Brit. J. appl. Phys.*, **6**, *No.* 10, 368–70 (*Oct.*, 1955).

A new effect is described in which the presence of a small source of heat at one electrode of a spark gap considerably reduces its breakdown voltage. The performance of the gap is investigated. A.

537.523.527

9677. Electrical breakdown in air at small and medium overvoltages. W. KÖHRMANN. *Z. angew. Phys.*, **7**, *No.* 4, 187–94 (1955) In German.

The breakdown voltage and formation time in dry air was carefully measured from 500 to 1 500 mm Hg. cm, with overvoltages of 0·1 to 20%. The values given by Schumann (1923) for this region are about 5% too high. Also the boundary between streamer formation and statistical breakdown lies higher than the accepted value of 1 000 mm Hg. cm. Observations of oscillographic records showed that the Townsend mechanism, characterized by a stepwise voltage fall, operates at small overvoltages, streamer formation occurring at higher overvoltages.

I. D. L. BALL

537.525 : 537.562

9678. Measurement of ion sheath in mercury vapor discharge at various pressures. Y. WATANABE, H. KOBAYASHI AND K. MITSUI. *J. Inst. Elect. Engrs Japan*, **74**, *No.* 9, 1053–5 (*Sept.*, 1954) In Japanese.

537.525 : 538.67

9679. Influence of a transverse magnetic field on the breakdown voltage of the discharge in a gas at high frequency. L. FERRETTI AND P. VERONESI. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 3, 639–43 (*Sept.*, 1955) In Italian.

Measurements were made in air at 0·1, 0·5; 1·0 mm Hg pressure and at 10, 15, 20, 25, 30 Mc/s. The magnetic field was varied from 0 to 650 gauss and the discharge tube had cylindrical electrodes. The results show a strong influence of the magnetic field on the breakdown voltage of the discharge. The results are discussed and compared with those of S. C. Brown *et al.* and of J. S. Townsend *et al.* which are the only ones published. A.

537.525.3 : 537.525.72 : 537.525.8

9680. On the secondary processes for the inception of a low frequency electric discharge in iodine vapour with glass electrodes. N. A. RAMAIAH, B. D. KHOSLA AND H. C. GAUR. Letter in *J. sci. industr. Res.*, **14B**, *No.* 5, 246 (*May*, 1955).

Briefly discusses secondary emission mechanisms, with reference to wall effects in low-pressure a.c. corona discharges. J. D. CRAGGS

537.525.8

9681. The light emission from high-vacuum gas discharges. K. H. REISS. *Z. angew. Phys.*, **7**, *No.* 9, 433–7 (1955) In German.

A photomultiplier tube was used, with suitable optical systems, to study the spectral composition of light from low-pressure (for example, $\sim 10^{-5}$ mm Hg) discharges of the Penning gauge type. Data are shown for various gases. J. D. CRAGGS

537.525.8

9682. Surface dependence of the Joshi effect in oxygen under silent electric discharge. S. R. MOHANTY. *J. sci. Res. Banaras Hindu Univ.*, **5**, *No.* 2, 11–16 (*June*, 1955).

Other things being equal, the negative Joshi effect $-\Delta i$ increases in proportion to the electrode surface area irradiated S_L: $-\Delta i/S_L$ = constant. The change in the value of this constant with variation in (the nature of) the electrode surface shows conclusively that the latter is of primary significance for the occurrence of the effect. A.

537.525.8

9683. Field intensity as a determinant of the Joshi effect under "normal" and "reversed" full- and semi-ozonizer excitation. S. R. Mohanty, R. Srinivasan, G. Srinivasan and T. S. Nagarjunan. *J. sci. Res. Banaras Hindu Univ.*, **5**, *No.* 2, 17–27 (*June*, 1955).

The negative Joshi effect $-\Delta i$ has been studied as a function of the applied field F under "normal" (N, inner tube/wire h.t.) and "reversed" (R, outer tube h.t.) full—and semi-ozonizer excitation. It is larger under R than under N. Opposite is the case with the "threshold potential" V_m. The effect $-\Delta i$ initially increases with F; the subsequent diminution is the consequence of a like change in the attachment probability $P = f(p/F)$, where p is the gas pressure. A.

537.525.8

9684. Comparative kinetics of the time development of the positive and negative Joshi effect in the halogens under "normal" and "wall influenced" discharge. B. M. Shukla. *J. sci. Res. Banaras Hindu Univ.*, **5**, *No.* 2, 76–99 (*June*, 1955).

The kinetics of the time variation of the Joshi effect $\pm\Delta i$ has been studied in chlorine, bromine and iodine under conditions of "normal" discharge and those produced in the presence of powdered wall material in the ionization space. The negative effect $-\Delta i$ increases with the duration of exposure to discharge, at a constant applied potential, to a stationary maximum. The positive effect $+\Delta i$, on the other hand, decreases either to a minimum, or changes sign to a constant maximum $-\Delta i$. The time variation of $\pm\Delta i$ follows relationship identical in form to the equation of the first-order chemical reaction velocity. That the change $+\Delta i \rightarrow -\Delta i$ is representable by a single equation shows that inversion is a continuous process. The diminution in $+\Delta i$ results from a reverse change in the associated $-\Delta i$. The observed stepwise increase of $-\Delta i$ in bromine vapour is indicative of the occurrence of consecutive reaction each characterized by a specific activation energy: every step corresponds to a different rate constant. These observations follow from Joshi's postulate of the formation on the electrode walls of an adsorption like layer primary to the production of $\pm\Delta i$. A.

537.525.8

9685. Light intensity and frequency as determinants of the potential inversion of the Joshi effect. S. R. Mohanty and P. Srinivasa Rao. *J. sci. Res. Banaras Hindu Univ.*, **5**, *No.* 2, 106–10 (*June*, 1955).

The positive Joshi effect $+\Delta i$, observed at low exciting potentials V, initially increases with V to a maximum at $V_{+\Delta i\,max}$, diminishes thereafter, and changes to the negative effect $-\Delta i$ at an inversion potential V_i. This V_i characterized by the condition $+\Delta i = -\Delta i$, diminishes with increase in the intensity I and the frequency ν of the irradiating light. Other things being equal, $-\Delta i$ increases with I and ν. For inversion to obtain at a larger I and ν therefore, $+\Delta i$ must increase proportionately. This is brought about through diminution in V towards $V_{+\Delta i\,max}$ and therefore, in V_i. A.

537.525.8

9686. Production of Joshi effect in paraffin wax solid-vapour interphase under silent discharge. M. V. Ramanamurti and V. Seethakara Rao. *J. sci. Res. Banaras Hindu Univ.*, **5**, *No.* 2, 116–28 (*June*, 1955).

The effect $\pm\Delta i$ is studied in ozonizers with annular wax coats and initial vacuum. A maximum Joshi effect, $-\Delta i$, as 95% current diminution, occurs even in the visible. As generalized by Joshi, a positive effect $+\Delta i$ is obtained below the threshold potential, V_m; $-\Delta i$ is (numerically) maximum near V_m. Increase of temperature reduces $-\Delta i$ and aids $+\Delta i$; that of light intensity and of light frequency as also "ageing" enhance both. Surface wax decomposes under discharge yielding C_2H_2, additional unsaturates and other inflammables; its iodine number increases appreciably. A.

537.525.8 : 537.212

9687. Measurement of electric fields as applied to glow discharges. R. W. Warren. *Rev. sci. Instrum.*, **26**, *No.* 8, 765–70 (*Aug.*, 1955).

Using a combination of well-known techniques, it has been possible to develop a magnetically compensating, ultra-fine, high-sensitivity, zero-deflection electron-beam probe method with automatic recording for measuring fields in glow discharges applicable to a wide variety of similar problems. Fields ranging from 1 000 down to 0·2 V per cm have been measured in one-twentieth or less the times required with previous techniques and with a gain in sensitivity by a factor of ten or better. Wall potentials can simultaneously be recorded. The method is limited to pressures below about 3 mm for 10 cm diameter glows by diffusion of the beam, but correspondingly greater pressures can be used in smaller tubes or with higher energy (say 50 kV) electron beams. The limitations imposed by the effect of the disturbing magnetic field on the discharge are indicated and examples are given of data taken in a glow discharge. A.

537.527

9688. The discharge between a positive point and a plane in compressed air and carbondioxide. A. Boulloud. *Rev. gén. Elect.*, **64**, *No.* 6, 283–99 (*June*, 1955) In French.

Sparkover in a 4 mm gap between a fine point ($<50\mu$ radius of curvature) and a plane electrode is preceded by glow discharge even at pressures exceeding 40 atm. With larger points glow discharge is observed only at lower pressures. A new type of dark discharge is observed with tungsten and molybdenum points. A theory is proposed for the initiation and suppression of corona; account is taken of the field distribution, external sources of ionization and the surface condition of the electrodes. J. H. MASON

X-RAYS 537.531

537.531 : 535.33/.34

9689. On the absorption and emission of röntgen rays by ferromagnetic metals. A. V. Sokolov. *Zh. éksper. teor. Fiz.*, **28**, *No.* 3, 326–9 (1955) In Russian.

Some aspects of this are calculated on the basis of the (s, d) exchange model [Abstr. 10634 (1954)].

Formulae are given for the absorption and emission probabilities near the *K*-shell energy and the results compared graphically with the predictions of the free electron model. J. HUGHES

537.531 : 535.33

9690. On the structure of the X-ray non-diagram lines $K\beta_\eta$ for elements from Cr(24) to Zn(30). M. SAWADA, K. TSUTSUMI, T. SHIRAIWA AND M. OBASHI. *J. Phys. Soc. Japan*, **10**, *No.* 8, 647–50 (*Aug.*, 1955).

With a bent-crystal X-ray spectrograph of the Cauchois type, the nondiagram line $K\beta_\eta$ was resolved into two components and the longer wavelength one was designated as $K\beta_\iota$ line. The intensity ratios of the $K\beta_\eta$ and $K\beta_\iota$ to the $K\alpha_1$ line were both estimated approximately to be the order of 10^{-4} or less. On the basis of the wavelength positions, the origin of these lines could be ascribed to the two-electron jump between the double-hole levels ($1s2p$) and ($2s3s$). The hypothesis of such a two-electron jump which obeys the Heisenberg selection rule was first proposed by one of the present authors. The $K\beta_\eta$ originates from the transition $KL_{II} - L_IM_I$, and $K\beta_\iota$ from $KL_{III} - L_IM_I$. A.

537.531 : 535.343

9691. Origin of double maxima in the *K*-edge of some potassium compounds. A. N. NIGAM. Note in *Naturwissenschaften*, **42**, *No.* 12, 365 (1955).

It is suggested that the double peak observed by Kiyono [Abstr. 5660 (1954)] is due to energy levels of the ejected electron when trapped in the large negative ion. This would explain the absence of a double peak in absorption curves of solutions of these salts.

A. R. STOKES

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533 : 621.384.612

9692. 300-MeV nonferromagnetic electron synchrotron. W. B. JONES, H. R. KRATZ, J. L. LAWSON, D. H. MILLER, R. D. MILLER, G. L. RAGAN, J. ROUVINA AND H. G. VOORHIES. *Rev. sci. Instrum.*, **26**, *No.* 9, 809–26 (*Sept.*, 1955).

An electron synchrotron, capable of accelerating electrons to energies of 300 MeV, which has been in operation for some time at the Research Laboratory, General Electric Company, is described. This machine uses no iron to produce the magnetic guide field. Electrons are injected at an energy of 100 keV, accelerated to 4 MeV by betatron action and to 300 MeV by synchrotron action. The magnetic fields for the betatron and synchrotron guide fields are produced directly by large currents flowing in coils suitably disposed near the electron orbit. The orbit diameter is 48 in. and a field of 16 000 Oe at the orbit is produced by a current pulse with an amplitude of 26 000 A. The entire coil system, together with the radio-frequency resonator and injector, is located in a vacuum. The repetition frequency is 15 pulses/sec, and the X-ray beam from an internal target has an intensity of about 2×10^{10} equivalent quanta/min through a collimator which transmits about 60% of the total beam. A.

537.533 : 621.384.612

9693. Theory of particle orbits in the alternating gradient synchrotron. G. LÜDERS. *Nuovo Cimento Suppl.* (*Ser.* 10) **2**, *No.* 1, 392–402 (1955).

An outline of the behaviour of betatron oscillations (to the linear approximation) in the perfect machine and under the influence of misalignments, twists and errors of field index. J. S. BELL

537.533 : 621.384.612

9694. The Italian design of a 1 000 MeV electron-synchrotron: a comparison between the strong and the weak focusing. G. SALVINI. *Nuovo Cimento Suppl.* (*Ser.* 10) **2**, *No.* 1, 442–58 (1955).

It is shown that the choice of injector is important and may affect the type of synchrotron selected. A Cockcroft–Walton set is chosen for the Italian machine. No final decision has yet been made between the constant-gradient (C.G.) and the alternating-gradient (A.G.) machines, but the differences to be expected are fully discussed in the light of extensive calculations by several workers. It is concluded that at this energy the C.G. machine may probably be the better, although the total magnet-gap volume would be just over four times that of the A.G. machine considered. J. H. FREMLIN

537.533 : 621.384.612

9695. A theory of the capture in a high energy injected synchrotron. E. PERSICO. *Nuovo Cimento Suppl.* (*Ser.* 10) **2**, *No.* 1, 459–69 (1955).

Particles are injected tangentially from the outside of the doughnut, without energy or angular spread. The fraction not striking the walls during the first few turns—the "instantaneous injection efficiency"—is assumed known. When the r.f. is subsequently switched on, the combined betatron and energy oscillations cause more particles to strike the walls. The number remaining is calculated, the results being presented as universal curves to facilitate specific computations. J. S. BELL

537.533.3

9696. Positive-ion drainage in magnetically focused electron beams. M. E. HINES, G. W. HOFFMAN AND J. A. SALOOM. *J. appl. Phys.*, **26**, *No.* 9, 1157–63 (*Sept.*, 1955).

In electron tubes utilizing long electron beams ionization of residual gases can produce a positive space charge which can partially or wholly neutralize the negative space charge of the beam. Such neutralization has, under special conditions, been successfully utilized in focusing electron beams. In certain electron devices requiring long electron beams, this type of focusing is inadequate and an axial magnetic field is employed to focus the electron beam. However, when magnetic focusing is used, the assumption is usually made that the electronic space-charge fields of the beam are not neutralized by positive ions. Measurements have been made on a magnetically focused electron beam yielding information on (*a*) the longitudinal drainage of positive ions from the electron beam, and (*b*) the degree of positive-ion neutralization of the electron beam. It is pointed out that localized ion traps may be present in the beam if the beam diameter varies periodically along its length because of the applied magnetic field. A.

537.533.33

9697. On the chromatic and spherical aberrations of electron-optical cylinder lenses. M. RHEINFURTH. *Optik*, **12**, *No.* 9, 411–16 (1955) In German.

It is shown analytically that the spherical and chromatic aberrations of cylindrical (i.e. two-dimensional) electron lenses are essentially finite. As in the case of rotational symmetry, the cylindrical lenses are weaker for paraxial rays and for fast electrons than for peripheral rays and for slow electrons. A.E.I. RESEARCH LABORATORY

537.533.35 : 621.385.833

9698. Experimental investigation of chromatic aberration in the electron microscope. S. KATAGIRI. *Rev. sci. Instrum.*, **26**, *No.* 9, 870–3 (*Sept.*, 1955).

Experimental results on the reduction of chromatic aberration in the magnetic electron microscope are described. It is proved that the chromatic field aberration can be completely compensated by a proper combination of two lenses with adequately designed pole pieces and the voltage stabilization tolerance is greatly improved. Micrographs with a resolution of about 5 mμ can be obtained even under a voltage fluctuation as large as $\Delta E/E = 1 \times 10^{-2}$. A.

537.533.7

9699. Measurement of electron energies by deflection in a uniform electric field. G. A. HARROWER. *Rev. sci. Instrum.*, **26**, *No.* 9, 850–4 (*Sept.*, 1955).

The well-known principle that the deflection of electrons in a uniform electric field can serve to measure the distribution of their energies, has been investigated both theoretically and experimentally. Simple theory suggests a particular choice of parameters for an instrument intended for such measurements. Design equations are presented, dimensions of a practical device are given, and the necessary associated electric circuits are discussed. An instrument of this type employs only an electric field, is small in size, is easily constructed, and provides a linear scale of energy values. An analyser built to this design with an overall length of 5 in. was able to completely separate electrons having a difference in their energies of 2%. A.

537.533.7 : 621.3.014.1 : 621.385.833

9700. An X-ray method for studying radial current distributions in electron beams. J. S. THORP. *Brit. J. appl. Phys.*, **6**, *No.* 10, 366–8 (*Oct.*, 1955).

An X-ray method is described for studying the radial distribution of current in low-voltage electron beams. The continuous X-ray spectrum is used. X-rays generated where the beam impinges on a thin foil are transmitted and produce an image of the transverse section of the beam on a film pressed against the foil. One application is in connection with mm-wave klystron development, and the potentialities of the method are illustrated by reference to beam studies with internally coated cathodes. A.

537.533.72 : 537.534.72

9701. The motion of charged particles in a homogeneous magnetic field with a superimposed linear current magnetic field and an electric field from a cylindrical condenser. V. M. KEL'MAN AND S. YA. YAVOR. *Zh. tekh. Fiz.*, **24**, *No.* 7, 1329–32 (1954) In Russian.

Certain particle trajectories are obtained by numerical integration for given values of the field strengths. Curves of the selected trajectories are given. J. HUGHES

537.533.74

9702. An automatic instrument for electron scattering measurements. L. MARTON, J. A. SIMPSON AND T. F. MCCRAW. *Rev. sci. Instrum.*, **26**, *No.* 9, 855–8 (*Sept.*, 1955).

An instrument capable of automatically recording the distribution in energy and angle of electrons scattered from solids is described. The energy range of the primary electrons is 10 to 50 keV. On a 2 sec cycle the instrument obtains and records an energy loss spectrum at a fixed angle, advances in angle and repeats. The instrument will distinguish energy peaks less than 20 V apart at 20 keV and angular details less than 10^{-3} radian apart. A.

537.533.75

9703. A comparison of the transmissions of electrons and positrons by thin metallic foils, studied by means of nuclear emulsions. G. MARGUIN AND M. MAITROT. *C.R. Acad. Sci.* [*Paris*] **241**, *No.* 2, 192–5 (*July* 11, 1955) In French.

The absorption of electrons and positrons was measured for thin foils of platinum and aluminium in the energy region 100–150 keV. The transmission coefficients of platinum differ but those of aluminium are effectively the same. Also the absorption limit for electrons in the platinum foil used differed from that for positrons by 13 keV, whereas for aluminium the absorption limits were the same. D. J. PROWSE

537.533.8 : 621.385.833

9704. A new fine-focus electron gun with indirectly heated tungsten "bolt" cathode and ion separation. E. B. BAS. *Optik*, **12**, *No.* 8, 377–84 (1955) In German.

The electron emission in this gun which is suitable for demountable systems is obtained from the end face of a cylinder of tungsten 0·6 mm in diameter. This cylinder is heated by electron bombardment from an encircling tungsten helix. An electron optical "brightness" of about 50–60% of the Langmuir value is obtained. The life of the tungsten cylinder is limited by evaporation at its hottest point. In an early design, the emitting power of the cathode was quickly reduced by ion bombardment. An electrostatic ion separator was then incorporated which resulted in cathode lives of 250 hours for a current density of emission of 1 to 2 amp/cm^2.

A.E.I. RESEARCH LABORATORY

537.533.8

9705. Out- and ingoing waves in final states and the bremsstrahlung. H. OLSEN. Letter in *Phys. Rev.*, **99**, *No.* 4, 1335 (*Aug.* 15, 1955).

The choice of final-state wave functions is of importance only if the differential cross-section for a given direction of scattered particle (final electron in the case of bremsstrahlung) is to be calculated. For the cross-section integrated over the direction of final particle, the choice is immaterial. G. E. BROWN

537.534

9706. Random errors and misalignments in the A/G [alternating gradient] proton linear accelerator. N. M. KING. *Atomic Energy Res. Establ.* [*Harwell*] *Mem. T/M*126, 24 *pp.* (1955).

Expressions have been derived for the effects of three types of random error in a "root-mean-square linear accelerator." These are: (*a*) misalignment of the zero-field (longitudinal) magnet axes; (*b*) rotations of the transverse magnetic axes (twists); and (*c*) errors in magnetic field magnitude. Type (*a*) is found to lead to "wander" of the entire proton beam around the design axis, while (*b*) and (*c*) result in radial expansion, or "blow-up" of the beam. The magnitude of these effects has been estimated for different r.m.s. values of the errors. The results indicate that a r.m.s., 0·010 in., misalignment of the zero-field axes creates a maximum beam wander of 0·54 cm, while a r.m.s. "twist" of 2° can cause a "blow-up" of 0·04 cm; a 2·5% r.m.s. error in field magnitude leads to a "blow-up" of 0·17 cm. It is suggested that correcting lenses should be provided to overcome "wander" and re-centre the beam. A.

537.534

9707. Permissible tolerances for a strong-focusing synchrotron. W. HUMBACH. *Z. angew. Phys.*, **7**, *No.* 9, 423–7 (1955) In German.

The effect of randomly distributed geometric or field errors on the particle motion is described by a diffusion from the stable trajectory. The adiabatic damping of the particle oscillations is neglected. The diffusion equation is used to relate design parameters and permissible particle loss to the required tolerances. The results are applied to the particular case of errors in the field exponent n, and a numerical example is discussed. E. A. ASH

537.534

9708. A circulation-system for ^{3}He. K. E. A. EFFAT AND J. H. FREMLIN. Note in *J. sci. Instrum.*, **32**, *No.* 9, 363–4 (*Sept.*, 1955).

The He^3 continuous-circulation system of the Birmingham cyclotron is described. Two small mercury diffusion pumps are used to pass the gas extracted from the cyclotron, consisting of helium contaminated with air, etc., through charcoal cooled in liquid air. The cleaned helium is then returned through a needle valve to the ion source.

J. H. FREMLIN

537.534

9709. Determination of proton synchrotron beam size with a crystal scintillator. B. LEDLEY AND L. RIDDIFORD. Note in *Proc. Phys. Soc. A*, **68**, *Pt* 9, 836–9 (*Sept.*, 1955).

Results of measurements made on the Birmingham synchrotron are presented and discussed.

J. J. WILKINS

537.534

9710. The extraction of the beam from the Liverpool synchrocyclotron. I. Theoretical. K. J. LE COUTEUR. *Proc. Roy. Soc. A*, **232**, 236–41 (*Oct.* 25, 1955).

The beam has been efficiently extracted by a magnetic deflector designed to produce radially unstable orbits while maintaining vertical stability. The theoretical specification of the apparatus is described. A.

537.534

9711. The extraction of the beam from the Liverpool synchrocyclotron. II. Experimental work. A. V. CREWE AND J. W. G. GREGORY. *Proc. Roy. Soc. A*, **232**, 242–51 (000, 1955).

Gives the practical application of the principles of Pt I, and the designs of the various components of the extraction system are described, as well as the procedure for optimizing the extracted proton-beam current. In the final result, 3% of the circulating beam was extracted from the cyclotron tank. The beam has an energy of 383 MeV with no measurable energy-spread. By the aid of an auxiliary focusing magnet, the beam has been focused into a fairly well defined spot, and the proton-flux per in.^{2} is at least 1000 times greater than that obtained from any similar machine. A.

537.534 : 621.384.611

9712. Synchrocyclotrons, and the CERN 600 MeV machine. T. G. PICKAVANCE. *Nuovo Cimento Suppl.* (*Ser.* 10) **2**, *No.* 1, 403–12 (1955).

A brief description of the principles of the synchrocyclotron is followed by a detailed description of the design and hoped-for performance of the CERN machine. A $\frac{3}{4}$-wave system is to be used for the dee and a vibrating-reed type of variable condenser is proposed, on which model tests have proved satisfactory. A stainless steel tank will be used and provision is made for up to 5·7 m of heavy concrete shielding. The arrangement of experimental space is discussed in detail. J. H. FREMLIN

537.534 : 621.384.612

9713. The alternating gradient proton synchrotron. J. B. ADAMS. *Nuovo Cimento Suppl.* (*Ser.* 10) **2**, *No.* 1, 355–74 (1955).

A brief history of the CERN proton synchrotron group is followed by a clear description of the principles of the alternating-gradient (A.G.) synchrotron. The methods of analysis of the various focusing problems are indicated and the detailed design figures for the proposed 25 GeV A.G. machine are given. It is shown that a constant-gradient machine with the same vacuum chamber dimensions would give only 5% of the current of the A.G. machine, and would also require impossibly close tolerances on the injection magnetic field gradient. J. H. FREMLIN

537.534 : 621.384.612

9714. Experimental facilities of the CERN proton synchrotron. A. CITRON AND M. G. N. HINE. *Nuovo Cimento Suppl.* (*Ser.* 10) **2**, *No.* 1, 375–91 (1955).

The best layout of shielding and of experimental space around the CERN synchrotron is discussed, taking into account the properties of 25 GeV protons as shown by cosmic-ray experiments. The most promising method of extracting a beam is thought to be by reducing its energy in a thick target to reduce its orbit radius and then 180° further on to "kick" it out with a deflecting magnet. The focusing of the resulting beam by an alternating-gradient magnetic field is discussed. J. H. FREMLIN

537.534.3

9715. On the counting of individual particles in mass-spectroscopic investigations. F. KIRCHNER AND H. KIRCHNER. Note in *Naturwissenshaften*, **42**, *No.* 1, 12–13 (1955) In German.

In connection with the work of Abstr. 9336 (1954) a method was devised of coupling a registering counter (e.g. for ions of ~10 keV), working at a pressure of 50–60 mm Hg, to the vacuum of a mass-spectrograph by means of two stops (diameters 0·1 and 0·2 mm), the intervening space being pumped by an oil diffusion pump. W. J. SWIATECKI

DISCHARGE TUBES . COUNTERS 537.54

537.542

9716. A high current proton source. P. C. THONEMANN AND E. R. HARRISON. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. No. GP/R*1190, 8 *pp.* (1955).

Proton currents approaching 20 mA at 10 kV can be produced from a moderately simple form of ion source in which the beam divergence is sufficiently small to be focused by an electrostatic lens. The increased gas flow, however, requires high pumping speeds to maintain suitably low pressures below the ion source. A.

537.542

9717. Delays in BF_3 proportional counters. K. P. NICHOLSON. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. No. N/R*1639, 7 *pp.* (1955).

The nature of the time delays introduced into neutron time-of-flight measurements by the use of boron trifluoride proportional counters is discussed and some experimental results are presented. The frequency distribution of counter pulses as a function of delay time is shown to correspond closely to that expected from theory. The experimental results are used to obtain a mean value for the mobility of electrons in BF_3. A.

537.542

9718. The self-absorption and window-absorption corrections in the 2π β-proportional counter for certain fission products. J. G. CUNINGHAME, M. L. SIZELAND AND H. H. WILLIS. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. C/R*1646, 6 *pp.* (1955).

The self-absorption, self-scattering and back-scattering corrections, and the window-absorption corrections have been measured for sixteen commonly used fission product nuclides in a 2π β-proportional methane flow counter. Growth curves have been measured for three of the nuclides and corrections for conversion electrons have been estimated for four. A.

537.542

9719. Residual counting-rate due to cosmic neutrinos in a system of Geiger–Müller counters in coincidence. A. PAPINEAU. *J. Phys. Radium*, **16**, *No.* 6, 468–72 (*June*, 1955) In French.

Details of a systematic investigation and reduction of the residual counting-rate are given. An attempt to detect neutrino-electron interactions was unsuccessful. J. J. WILKINS

537.542

9720. Effect of circuit loading on the production of oscillations in halogen-quenched G-M counters. W. G. EGAN. Note in *Rev. sci. Instrum.*, **26**, *No.* 9, 891 (*Sept.*, 1955).

537.542 : 539.185.08

9721. A fission counter with high fissile material density for fast neutron fission counting. W. D. ALLEN AND A. T. G. FERGUSON. *J. nuclear Energy*, **2**, *No.* 1, 38–40 (*Aug.*, 1955).

A multiplate counter is described which contains up to 100 mg of fissile material within one cubic inch with a plate capacity of about 100 pF. It is reasonably robust, and has a transmission coefficient for fast neutrons of 93% and the quantity of fissile material can be easily varied. A.

537.542 : 550.93

Liquid scintillation techniques for radiocarbon dating. *See Abstr.* 10101

537.542 : 621.387.464

9722. The physics of the scintillation counter. G. F. J. GARLICK. *J. sci. Instrum.*, **32**, *No.* 10, 369–71 (*Oct.*, 1955).

The resolution and performance of scintillation counters used as energy spectrometers are limited by several factors due to the various physical processes involved. The spread in output pulse magnitude when detecting monoenergetic particles is, in the ideal case, due to the statistical fluctuations in the number of photoelectrons produced at the photomultiplier cathode and collected by the first multiplying stage. In practical usage contributions to the pulse spread may be due in particular to events in the scintillator and in the secondary emission processes in the multiplier. A critical discussion of the above factors is given and also of the problem of non-linear variation of phosphor response with energy and nature of the incident radiation. A.

537.542

9723. A stabilized high-voltage supply. N. G. CHAPMAN. *New Zealand J. Sci. Technol. B*, **36**, *No.* 6, 632–9 (*May*, 1955).

A supply suitable for nuclear physical work, and of good stability and versatility, is described. A.

537.542

9724. Fast coincidence system with amplitude discrimination and accidentals monitoring. G. S. STANFORD AND G. F. PIEPER. *Rev. sci. Instrum.*, **26**, *No.* 9, 847–9 (*Sept.*, 1955).

A coincidence system with a short resolving time, variable up to 120 millimicroseconds, has been developed for use in $(\alpha, p\gamma)$ and $(d, p\gamma)$ correlation investigations. The system is a "slow-fast" one in that amplitude selection in both channels is made before the pulses reach the fast coincidence circuit, while accurate timing is achieved by parallel delaying and sharpening networks in each channel. The advantage of the slow-fast method is that it permits the inclusion in a simple way of an accurate monitor for accidental coincidences, thus allowing continuous accidentals monitoring while an experiment is in progress. A description of the whole system and details of new circuits and special components are given. A.

537.542 : 539.166.08

9725. Stabilising scintillation spectrometers with counting-rate-difference feedback. H. DE WAARD. *Nucleonics*, **13**, *No.* 7, 36–41 (*July*, 1955).

The gain in the spectrometer circuit is maintained constant by varying the photomultiplier potential as required in order to keep a monitoring single channel kicksorter lined up on a single peak in the spectrum. Any shift in the peak detected by the monitoring kicksorter results in an automatic change in the photomultiplier h.t. supply to compensate the shift. If no convenient peak occurs in the spectrum under investigation, then an extra source of monoenergetic light pulses can be introduced. L. R. SHEPHERD

537.542 : 539.166.08

Gamma-ray scintillation spectrometer with logarithmic pulse-height response. *See Abstr.* 9883

537.542

9726. Luminescent camera. E. K. ZAVOĬSKIĬ, G. E. SMOLKIN, A. G. PLAKHOV AND M. M. BUTSLOV. *Dokl. Akad. Nauk. SSSR*, **100**, *No.* 2, 241–2 (1955) In Russian.

The tracks of ionizing particles in luminescent media can be made visible using an electron-optical image convertor. Photographs are given of stars produced in a crystal of caesium iodide by fast neutrons. J. HUGHES

537.542

9727. A 9″ expansion cloud chamber. H. S. TOMLINSON, E. W. TITTERTON AND G. F. SNELLING. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. G/R*1010, 4 *pp.* (1955).

A design of expansion chamber which minimizes difficulties from turbulence is described. It has a diameter of 9 in. and a pulsed coil system can be used to give a magnetic field of 10 000 gauss over the chamber volume. A.

537.542

9728. Photometric determination of ionization of cloud-chamber tracks. E. K. BJÖRNERUD. *Rev. sci. Instrum.*, **26**, *No.* 9, 836–43 (*Sept.*, 1955).

A photoelectric method for measuring the specific ionization of tracks on cloud-chamber photographs is described. An important feature of the method is the use of a comparison track of known ionization in the same part of the chamber. A microphotometer slit is made to scan the track perpendicular to its direction, and a tracing of the transmission of the track relative to the background transmission is obtained. A parameter relating the transmission of the track in question to the transmission of the comparison track is obtained directly from the tracings. Identified π-μ-decays are used to establish a calibration curve, and the method is applied to various unknown tracks. The error of measurement is of the order of 10%. A theoretical treatment of the problem is carried out to show the effects of various physical parameters not easily ascertained experimentally. A.

537.542

9729. Operation conditions of a bubble chamber (n-pentane, iso-pentane and diethyl ether). L. BERTANZA, G. MARTELLI AND A. ZACUTTI. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 3, 487–94 (*Sept.*, 1955).

A general criterion for calculating the operational conditions is deduced. Numerical tables are given for n-pentane, iso-pentane and diethyl ether. A.

537.543 : 621.387.015.5

9730. Initiation of hot-cathode discharges. N. R. DALY AND K. G. EMELEUS. *Brit. J. appl. Phys.*, **6**, *No.* 10, 370–2 (*Oct.*, 1955).

An experimental study has been made of the effect of a voltage fall along a hot cathode on the initiation of a gas discharge in a diode at low pressure. Plasma forms first near the negative end of the cathode and spreads along the cathode with increase in tube current. Positive ions diffuse in the inter-electrode space towards the positive end of the cathode, where the potential difference between cathode and anode when plasma is present may be well below the ionization potential of the gas. Observations have been made on the appearance of the discharge before and after plasma forms, and on oscillations generated by the discharge. A.

IONIZATION . THERMIONICS 537.56/.58

537.564

9731. A semiempirical expression for the first Townsend coefficient of molecular gases. R. W. CROWE, J. K. BRAGG AND J. C. DEVINS. *J. appl. Phys.*, **26**, *No.* 9, 1121–4 (*Sept.*, 1955).

The general utility of an approximate expression for the first Townsend coefficient of a gas, derived several years ago by Druyvesteyn and Penning, has been tested by introducing into the theoretical treatment somewhat more realistic assumptions regarding the relevant scattering cross-sections of the gas molecule. It has been demonstrated by numerical calculations that the functional dependence of the Townsend α upon the electric field and the gas pressure is, within certain limits, insensitive to the assumed energy dependence of the elastic and inelastic cross-sections. The functional form of the inelastic cross-section does, however, influence the way in which the ionization energy of the gas molecule enters in the exponential part of the expression. A.

537.564

9732. Studies of the ionization of molecules by electron impact. I. Excited states of the nitrogen molecular ion. D. C. FROST AND C. A. MCDOWELL. *Proc. Roy. Soc. A*, **232**, 227–35 (*Oct.* 25, 1955).

A recently developed pulse technique which produces a beam of electrons with an energy spread of only 0·1 eV has been used to determine the ionization efficiency curve for molecular nitrogen in a mass spectrometer. Ionization to all four known excited states of the N_2^+ ion, including the recently identified $^2\Pi_u$ state, are clearly recognizable on the ionization efficiency curve. The several ionization potentials of the nitrogen molecule, as given by this new electron impact method, are in good agreement with the values deduced from spectroscopic data. The results are also shown to be in agreement with the expecta-

tions of the molecular orbital formula for nitrogen given some years ago by Mulliken (1932). A.

537.564 : 535.343

Photoionization efficiencies and cross sections in C_2H_4 and C_2H_2. *See Abstr.* 9564

537.565

9733. The problem of cold probes. Flux of ions captured by a cylindrical conductor placed in a uniform ionizing electric field. R. Cochet and J. Dupuy. *C.R. Acad. Sci.* [*Paris*] **241,** *No.* 3, 283–5 (*July* 18, 1955) In French.

The ion flux is determined as a function of the charge on the cylinder. Experimental results obtained with a cold probe are in agreement with those obtained using incandescent probes [Abstr. 7152 (1955)] and estimates of the ionic mobility in the atmosphere obtained in this study agree with recently determined values [Abstr. 8057 (1955)]. C. G. MORGAN

537.583 : 621.385.032.216

9734. Oxide-impregnated nickel-matrix cathode. W. Balas, J. Dempsey and E. F. Rexer. *J. appl. Phys.*, **26,** *No.* 9, 1163–5 (*Sept.*, 1955).

A new cathode is described consisting of an oxide-impregnated nickel matrix. A sintered nickel matrix of controllable porosity is prepared and impregnated with solutions which precipitate a mixed carbonate within the matrix. The resulting cathode is a dispenser type with a minimum of surface coating. The cathodes can be activated by schedules which approximate those of a normal oxide-coated cathode. Pulse-emission tests of these cathodes show properties intermediate between the oxide-coated cathode and the *L*-cathode, and of the same order as the moulded cathode described by McNair, Lynch and Hannay. A.

537.583 : 621.385.032.216

9735. Emission from hollow cathodes. K. M. Poole. *J. appl. Phys.*, **26,** *No.* 9, 1176–80 (*Sept.*, 1955).

The results of a phenomenological study of hollow cathodes are presented. Evidence has been accumulated to show that an oxide-coated hollow cathode has two regions of emission with significantly different properties. These are believed to be the coated inner surface of the cavity and a deposit of crystalline material formed on the orifice edge by evaporation from the original coating. Measurements of the relative importance of the two sources have been made under various conditions. A.

COSMIC RAYS 537.591

537.591.1

9736. Changes in the low-energy particle cutoff and primary spectrum of cosmic radiation. P. Meyer and J. A. Simpson. *Phys. Rev.*, **99,** *No.* 5, 1517–23 (*Sept.* 1, 1955).

The low-rigidity cutoff for particles in the primary cosmic-ray spectrum has decreased within the period 1948 through 1951. This decrease corresponds to a 3° change (northward) in the "knee" position of the geomagnetic latitude curve for the nucleonic component. The phenomenon is accompanied by both a change in the primary spectrum for particle rigidities less than approximately 4 BV and by an increase in total primary intensity. The spectral change is such that if the differential primary intensity, j, at low rigidities in 1948 was $j = C(p/z)^{-2}$; then the new spectrum for 1951 through 1954 is approximately $j \simeq C'(p/z)^{-2\cdot7}$. The total change of intensity arising from the changes in spectrum and low-rigidity cutoff is more than 13%. The measurements were obtained in 1948 and 1951, and have been confirmed and extended in November, 1954, using nucleonic component detectors. The vertical charged particle intensity was also measured and displays changes equivalent to those reported for the nucleonic component. Three regions of space are considered for the location of the mechanism producing the low-energy cutoff; namely, the vicinity of the earth, the region of the solar system, and regions of the galaxy outside our solar system. Although the general solar dipole moment is at least an order of magnitude too small to account for the observations, it is concluded that the mechanism is operative within the solar system and is not a terrestrial phenomenon. A.

537.591.15

9737. The breaking-up of heavy primary nuclei in cosmic radiation into α-particles. F. Hänni. *Helv. phys. Acta*, **28,** *No.* 4, 345–6 (1955) In German.

The formation of α-particle showers due to the breaking-up of heavy primaries in collision with emulsion nuclei is briefly discussed. The energies of the α-particles determined by different methods have been compared. The energy can be estimated from the angle of opening of the shower but scattering measurements are more precise. On a total length of 231 cm of α-particle track, 12 interactions were found giving a mean free path of 77 ± 22 g/cm^2 in emulsion. D. J. PROWSE

537.591.15

9738. Fluctuations in the number of photons in an electron-photon cascade. A. Ramakrishnan and S. K. Srinivasan. *Progr. theor. Phys.*, **13,** *No.* 1, 93–9 (*Jan.*, 1955).

Numerical results are given relating to the mean and mean-square number of photons in a cosmic-ray cascade, to supplement those given earlier by Ramakrishnan and Mathews [Abstr. 8395 (1954)] relating to electron distribution. A.

537.591.15

9739. On the extensive air showers penetrating 10 cm of lead observed at 2,760 meters above sea level. I. Miura, T. Matano, Y. Toyoda and T. Murayama. *J. Phys. Soc. Japan*, **10,** *No.* 8, 595–99 (*Aug.*, 1955).

The density distribution and the zenith angle distribution of extensive air showers were measured at 2 760 metres elevation, geomagnetic latitude 25° N, by a cloud chamber in connection with a hodoscope consisted of Geiger counter trays shielded by lead absorbers. Results obtained were as follows: (1) The integral density spectrum of the extensive air showers followed the power law distribution and its exponent was $1{\cdot}70 \pm 0{\cdot}13$. (2) The projected angle distribution of the extensive air showers followed the empirical law of $\cos^n\theta$, where $n = 6{\cdot}9 \pm 1{\cdot}3$. A.

537.591.15

9740. Detailed analysis and discussion of two narrow showers of pairs of charged particles. A. Debenedetti, C. M. Garelli, L. Tallone and M. Vigone. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 2, 220–30 (*Aug.*, 1955).

Detailed experimental data on two events consisting of a narrow shower of pairs of charged particles are reported. An analysis of the common features of the events points out some difficulties in the explanation of the phenomenon as an ordinary cascade shower. Other possible interpretations are suggested. A.

537.591.15

9741. On the penetrating showers produced in paraffin and graphite. I. Miura. *J. Phys. Soc. Japan*, **10**, *No.* 9, 741–8 (*Sept.*, 1955).

The production of the penetrating showers in paraffin and graphite was studied by a cloud chamber connected with a hodoscope at an elevation 2760 m, geomagnetic latitude 25° N. Results indicate: (1) there is evidence of multiple production of mesons in the collision of an incident nucleon with a hydrogen nucleus; (2) there is no appreciable difference between paraffin and graphite in the projected angle distribution of lightly ionizing shower particles with respect to the primary particles; (3) the flux of ionizing particles which produce local penetrating showers is $(3{\cdot}0 \pm 0{\cdot}4)\times10^{-5}$/cm^2 sec sterad. A.

537.591.15

9742. Momentum spectrum from scattering in lead of sea level penetrating shower secondaries. D. L. Dye. *Phys. Rev.*, **99**, *No.* 5, 1458–9 (*Sept.* 1, 1955).

A momentum spectrum of sea-level penetrating shower particles has been determined from multiple Coulomb scattering angle measurements on tracks traversing two lead plates in a cloud chamber. The distribution of scattering angles is consistent with a differential momentum spectrum $N(p)$ proportional to p^{-1} for the range 0·6 to 2 BeV/c; and to p^{-2} for the range 2 to 6 BeV/c. A.

537.591.15

9743. Problem in shower theory (approximation *A*). R. C. O'Rourke and A. Anderson. *Phys. Rev.*, **99**, *No.* 5, 1484–90 (*Sept.* 1, 1955).

The Bhabha–Heitler method for solving the shower equations in approximation A is applied to the problem of showers initiated by a primary spectrum of photons. Numerical results have been obtained, by using the Naval Research Electronic Computer, for the practical case of a primary spectrum of the familiar high-energy bremsstrahlung shape. A.

537.591.15

9744. Cosmic-ray ionization bursts in an unshielded 8-inch pressurized sphere at sea level. H. Carmichael and J. F. Steljes. *Phys. Rev.*, **99**, *No.* 5, 1542–50 (*Sept.* 1, 1955).

Two thin-walled ($\frac{1}{16}$ in. steel = 1·22 g. cm^{-2}) spherical ion-chambers, 8 in. in diameter, filled with best quality (99·8%) commercial cylinder argon at 50 atmospheres, have been used to measure cosmic-ray ionization bursts near sea level. The bursts in one ion-chamber were measured by means of a vibrating reed electrometer and in the other by an electrometer tube and d.c. feedback amplifier. The results from the two ion-chambers agreed to within 2% except that the smallest bursts could not be detected with the vibrating reed instrument. The integral size-frequency distribution of the bursts is given for sizes from 2×10^4 to 3×10^7 ion-pairs and the corresponding frequencies range from 3×10^4 to 3×10^{-4} bursts per hour. The size-frequency distribution has been separated into five components identified respectively with single μ-mesons, electrons, single protons, star processes, and extensive electron showers. These components have been resolved by comparison of the unshielded distribution with that obtained under a 27 cm lead shield and the interpretation of their origin has been confirmed by coincidence experiments involving Geiger counters, a Cherenkov proton selector, and other ion-chambers. The existence of a sharp kink in the size-frequency distribution curve, similar to that reported by Carmichael and Chou in 1939, is confirmed. A.

537.591.2

9745. Absolute low-energy differential range spectrum of cosmic ray μ-mesons at sea-level. D. Brini, L. Peli, O. Rimondi and P. Veronesi. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 3, 613–38 (*Sept.*, 1955).

The results are given of a measurement of the differential range spectrum of μ-mesons between 0 and ~1·5 m.w.e. at sea-level. The experimental apparatus used consists of two liquid scintillation counters, placed in coincidence with each other. Between them there is the lead absorber. The lower counter, of 5·64 g/cm^2 thickness, works as a "death" thickness. The event $\mu\rightarrow e$ is detected by photographing the two successive pulses, due to the meson and electron, on a synchroscope screen. The experimental results have been corrected for any possible cause of error. The scattering correction has been determined by the Monte Carlo method, and experimentally verified. The results corresponding to the scattering correction show how great this influence can be. The absolute intensity at range of ~150 g/cm^2 of a.e. is found to be 7×10^{-6} (sterad.g.s)$^{-1}$. The behaviour of the spectrum between 0 and 180 g/cm^2 of a.e. results in a slope of 0·091 ± 0·006. A.

537.591.5

9746. Studies on daily variations of cosmic radiation with a large ionization chamber. A. Sittkus. *J. atmos. terrest. Phys.*, **7**, *No.* 1–2, 80–9 (*Aug.*, 1955) In German.

Studies were made with a shielded ionization chamber of 60 cm diameter and 180 cm length. The results of abnormal daily variations are discussed. A.

537.591.5

9747. On the momentum spectrum of μ-mesons near sea-level at 24° N. S. Fukui, T. Kitamura and Y. Murata. *J. Phys. Soc. Japan*, **10**, *No.* 9, 735–41 (*Sept.*, 1955).

The momentum spectrum of μ-mesons near sea-level and at geomagnetic latitude 24° N has been obtained by means of a magnet cloud chamber. Above 700 MeV/c the results are in agreement with the momentum spectrum derived from Olbert's production spectrum at 24° N. At lower momenta, the spectrum is found to decrease more rapidly than the corresponding spectra derived from differential

range measurements. This discrepancy, which is not understood, may be due to some systematic error in either the magnetic deflection or differential range method. A.

537.591.5

9748. Solar influence on the anisotropy of primary cosmic radiation. I. Studies at low latitudes. V. Sarabhai, U. D. Desai and D. Venkatesan. *Phys. Rev.*, **99**, *No.* 5, 1490–502 (*Sept.* 1, 1955).

A study of the daily variation of meson intensity at low latitudes has been conducted with counter telescopes of identical design at Ahmedabad and at the mountain station of Kodaikanal. The analysis of the data shows that the semidiurnal component of variation, like the diurnal component, undergoes significant long-term changes. The appropriateness of a barometric coefficient applicable to the daily variation of meson intensity is discussed. Long-term changes of the daily variation reveal that these are due to the addition or attenuation of a day and a night contribution, both of which are principally diurnal in character and at Ahmedabad have maxima at about 1300 and 0300 hours, respectively. For corroboration of these findings, data from 1937 to 1952, from the Carnegie Institution stations of Huancayo and Cheltenham have been analysed. While at the equatorial station of Huancayo, the mechanism of change of daily variation is similar to what is observed at Ahmedabad and Kodaikanal, there are some differences in detail at Cheltenham, which lies in middle latitudes. There is evidence that some characteristics of the daily variation, notably the hour of maximum of the diurnal component and the amplitude of the semidiurnal component, follow the eleven-year solar cycle of activity. However, there is an indication that the nature of the composite daily variation, the hour of maximum of the semidiurnal component, and the pattern of addition and attenuation of the day and night contributions follow a 22-year cycle of change. The activity of the day and night contributions in relation to solar activity is discussed. A.

537.591.5 : 550.385

9749. On the correlation between geomagnetic activity and the diurnal variation of cosmic rays. A. E. Sandström. *Tellus*, **7**, *No.* 2, 204–14 (*May*, 1955).

The cosmic-ray measurements of K.-G. Malmfors (1949), Oct. 1947–May 1950, have been studied with regard to the effect of geomagnetic activity on the diurnal variation. By means of the same data a study was also made of the secular phase shift first noticed by Elliot and Thambyaphillai (1953). The time of maximum has been found to decrease with increasing values of the international K_p-index, while the amplitude itself increases. These effects were studied for the registration period as a whole as well as for short intervals. The statistical fluctuations are too big for the study of intervals shorter than half a year. The secular phase shift is the same regardless of direction. Also the phase shift accompanying geomagnetic activity is independent of the direction of measurement. This is a good proof that both shifts are due to changes in the original direction of the primaries. It is also shown that the secular phase shift is independent of the daily geomagnetic disturbances. Apparently two effects exist, both resulting in a change of the direction of the primary cosmic-ray particles. A.

537.591.8

9750. Observations of slow particles and stars in nuclear emulsions exposed at 17 m.w.e. underground. S. Kaneko, T. Kubuzoe, M. Okazaki and M. Takahata. *J. Phys. Soc. Japan*, **10**, *No.* 8, 600–9 (*Aug.*, 1955).

Observations were carried out at a depth of 17 m.w.e. underground by nuclear plates made from Ilford G5 emulsions in gel form. The frequencies of μ-mesons and protons coming to rest in the emulsions were found to be $0{\cdot}262 \pm 0{\cdot}008\,\mathrm{cm^{-3}\,day^{-1}}$ and $0{\cdot}049 \pm 0{\cdot}004\,\mathrm{cm^{-3}\,day^{-1}}$, respectively. The angular distribution of these slow protons was found to be isotropic and so they are regarded as being of secondary origin from fast μ-mesons underground. In addition to the stars of the types of $N_h + 1_p$ with $N_h \geqslant 3$, several stars of the types of $1 + 1_p$ and $2 + 1_p$ were found with a cross-section for production of a few times $10^{-30}\,\mathrm{cm^2}$ per nucleon. Some of the stars of the type of $1 + 1_p$ may possibly be explained by photoproton production through the giant resonance absorption by emulsion nuclei of virtual photons associated with high-energy μ-mesons. A.

MAGNETISM 538

538.082 : 541.67

The influence and the elimination of the ferromagnetic susceptibility in magneto-chemical investigations by the cylinder method. *See Abstr.* 10051

538.083 : 621.317.444

9751. An electronic magnetometer. B. G. Cragg. *J. sci. Instrum.*, **32**, *No.* 10, 385–6 (*Oct.*, 1955).

A probe unit containing a miniature c.r.t. is brought into the field to be measured, and the resulting deflection of the electron beam is automatically compensated by a voltage applied to the electrostatic deflecting plates. This voltage is proportional to the magnetic field for steady fields and for fields changing at not more than 10 kc/s. Using standard components an output of 12·5 V/oersted is obtainable with a drift of about 1 mV/min. The smallest field measurable is thus 10^{-4} oersted. A.

538.083.9

9752. Nuclear magnetic resonance and the measurement of magnetic fields. R. L. Driscoll. "Precision electrical measurements," *Paper* 8, 9 *pp. London: Her Majesty's Stationery Office* (1955).

The correlation of the nuclear properties of atoms and mechanical units provides a method of measurement of magnetic fields. Work by Purcell [Abstr. 4849 (1954)] and Bloch [Abstr. 4848 (1954)] is quoted in which simple electromagnetic methods were derived for detecting nuclear magnetism in matter of ordinary density. The present paper continues the theory and describes an experimental arrangement with some results which are compared with those found by other methods. Block diagrams and circuits are given.

E. H. W. BANNER

538.1

9753. Field strength and induction. M. PROMBERGER. *Elektrotech. Obzor*, **43**, *No.* 7, 362–6 (1954) *In Czech.*

It is shown that the matrix of material constants can be taken as a tensor which makes a given expression invariant with regard to the Lorentz transformation and can be used not only in the theory of relativity, but in an adapted form it can also be applied to any anisotropic medium whether inert or in motion. Two identities are inferred in an isotropic stationary medium, namely the relationship between magnetic field strength and flux density (induction), and the law of Ohm, by resolving the electromagnetic field and the density of electric current into four-dimensional tensor quantities. As the same medium in motion will appear to a stationary observer in a different way, the tensor defining the effect of moving mass on substances of a stationary medium will display anisotropic properties towards the matrix of material constants and the electric field will affect the magnetic one and vice versa. Consequently, the above process is repeated in an anisotropic medium, in which the relationship between field strength and induction is presented in expressions governed by the constants of vacuum and by the matrix of anisotropy.

J. C. STARK

538.1 : 517.37

A new vector transformation of a curvilinear integral into a surface integral and its application in magnetostatics. *See Abstr.* 9350

538.1 : 539.15

9754. Neglected elements in classical electromagnetism: their possible utility in the theory of the atom. H. VARCOLLIER. *Arch. Sci.* [*Geneva*] **8**, *No.* 2, 137–77 (1955) In French.

It is suggested that nuclear moments, interaction of protons, etc., should be described by classical concepts.

G. E. BROWN

538.113 : 539.133

9755. The diamagnetic susceptibilities of methane and the ammonium ion. K. A. VENKATACHALAM AND M. B. KABADI. *J. phys. Chem.*, **59**, *No.* 8, 740–1 (*Aug.*, 1955).

Coulson's calculations for the diamagnetic susceptibility of methane, based on electron pair method, have now been modified by including the ionic part of the wave-function. The value $0{\cdot}40\times10^{-18}$ e.s.u. has been used for the C–H bond moment. The value so obtained has been shown to be in better agreement with experiment, than any previously calculated value. Similar calculations have been made for the ammonium ion also, and the result obtained agrees fairly well with the experimental value.

A.

538.114

9756. On the density of states of the conduction electrons in ferromagnetics. A. V. SOKOLOV AND S. M. TSIPIS. *Zh. éksper. teor. Fiz.*, **28**, *No.* 3, 321–5 (1955) In Russian.

Calculates the density of states for the *s*-electrons as a function of the magnetization.

J. M. RADCLIFFE

538.114

9757. The theory of Néel "spikes" and of the coercive force due to the formation of cylindrical secondary domains. R. BRENNER. *Z. angew. Phys.*, **7**, *No.* 8, 391–7 (1955) In German.

The theory of Néel spikes is extended by investigating the dependence of their size on the presence of an external field and on the temperature. The condition for the formation of spikes, depending on the nature of the non-ferromagnetic inclusions, is discussed. The formation of cylindrical secondary domains during the motion of 180° walls past the inclusions is considered, and the lengths of the cylinders before separation from the inclusions are calculated. Earlier formulae for the coercive force are modified by this effect.

E. P. WOHLFARTH

538.114

9758. Statistical models of ferrimagnetism. I. SYOZI AND H. NAKANO. *Progr. theor. Phys.*, **13**, *No.* 1, 69–78 (*Jan.*, 1955).

The temperature-dependence of some idealized ferrimagnetic crystals is studied. The whole lattice of the crystal discussed here can be divided into two sublattices. These sublattices are generally inequivalent to each other, and any lattice points of one sublattice L_1 is nearest-neighbouring to some number of lattice points belonging to another sublattice L_2 and vice versa. Every lattice point of L_1 is occupied by a certain kind of magnetic atom A_1 and that of L_2 by another kind of magnetic atom A_2. In this configuration there exists an antiferromagnetic coupling between every pair of A_1 and A_2 nearest-neighbouring each other. A_1-atoms and A_2-atoms have their own magnetic moment generally different from each other. Without introducing any approximation, the spontaneous magnetization of such a ferrimagnetic Ising model is computed by making use of the Onsager theory and especially of the solution of the temperature-dependence of the spontaneous magnetization of the plane square lattice obtained by Yang. The exact results obtained for the magnetic behaviour of the idealized simple model are quite similar in character to those of the actual ferrimagnetic crystal computed by Néel in the Weiss approximation.

A.

538.114

9759. Antiferromagnetism. W. MARSHALL. *Proc. Roy. Soc. A*, **232**, 48–68 (*Oct.* 11, 1955).

The ground state of a lattice with one electron per atom and antiferromagnetic interactions between nearest neighbours only is examined by a variational method similar in principle to the treatments by Hulthén (1938) and Kasteleijn (1952) of the linear-chain problem. The calculation involves a statistical problem which is shown to be exactly equivalent to the Ising ferromagnetic problem. This cannot be solved exactly, except in the one-dimensional case, and so the Bethe–Peierls method is used to solve it approximately. In complete contradiction to the Kubo (1953) variational calculation it is concluded that all lattices have disordered ground states. The energy differences between ordered and disordered states are small and so the nature of the ground state is likely to be sensitive to small additional ordering forces.

A.

538.114

9760. The spin-wave theory of antiferromagnetism. W. MARSHALL. *Proc. Roy. Soc. A*, **232**, 69–77 (*Oct.* 11, 1955).

Various criticisms of the spin-wave theory of antiferromagnetism are discussed. In particular, it is pointed out that the use of the Holstein–Primakoff

(1940) notation introduces into the formulae large contributions from fictitious states which have no physical existence. This is in contrast with the ferromagnetic problem where contributions from these fictitious states are negligible. Hence conclusions drawn from the spin-wave theory, particularly as to the conditions required for antiferromagnetism, are not to be relied upon. A.

538.114

9761. The effect of particle interaction on the coercive force of ferromagnetic micropowders. E. P. WOHLFARTH. *Proc. Roy. Soc. A*, **232**, 208–27 (*Oct.* 25, 1955).

Previous theoretical work by Stoner and Wohlfarth [Abstr. 1877 (1948)] on the magnetic properties of single domain ferromagnetic particles is extended to take some account of the interaction between the particles. Earlier theoretical considerations of the interaction problem are critically discussed, and the experimental results for micropowder materials under different degrees of compression are reviewed. A general relation for the magnetic interaction energy of two prolate spheroidal particles is derived. The magnetic properties of assemblies of parallel particles (two particles, linear chains, two- and three-dimensional assemblies) are discussed, and relations are derived for the coercivity change due to the interaction. Results are similarly derived for two non-parallel particles and for ordered assemblies of such particles. The two principal effects of interaction which have been covered are an interaction-dependence of the effective shape anisotropy coefficient, and a mutual magnetization change due to an interaction-dependent rotation of the magnetization vectors. Both these effects are in general present and as a result the coercive force H_c depends on the interaction, being given by the general relation $H_c(p) = H_c(0) - I_0(Ap + Bp^{\frac{3}{2}} + \ldots)$, where p is the packing factor and I_0 the saturation magnetization. The coefficients, particularly A, may depend critically on the orientations and the geometrical arrangement of the particles. This formula is contrasted with those obtained previously, based on an "effective field" treatment. A.

538.114 : 538.24

9762. The spontaneous magnetization of a one-dimensional model of a ferromagnetic toroid in a magnetic field. L. VALENTA. *Czech. J. Phys.*, **5**, *No.* 3, 291–9 (*Aug.*, 1955).

Deals with the derivation of the dependence of the spontaneous magnetization on the temperature and the intensity of the magnetic field for a one-dimensional model of a ferromagnetic toroid. For a chain formed of $N \lesssim 10H^{-\frac{1}{2}}$ particles this dependence has the form of a half-power law modified by exponential dependence on H/T for temperatures and intensities of the magnetic field for which $H/T \gtrsim 10$. A.

538.22 : 538.63

9763. On the galvanomagnetic effects in *n*-type indium antimonide. Y. KANAI. Note in *J. Phys. Soc. Japan*, **10**, *No.* 8, 718–19 (*Aug.*, 1955).

Reports results of measurements of the Hall constant and the magnetoresistance in magnetic fields up to 10^4 oersted for an InSb specimen with electron density $2{\cdot}9\times10^{17}\,cm^{-3}$ and carrier mobility $2\times10^4\,cm^2.V^{-1}.sec^{-1}$. The Hall constant was found to be independent of field strength at −136°C, but the relative resistance change, both longitudinal and transverse, to be strongly dependent on it, reaching the value 0·2 at the highest fields applied and at temperatures −170° and −146°C respectively. The results are briefly discussed. E. P. WOHLFARTH

538.221

9764. The manifestation of nuclei of reverse magnetization of iron-nickel wires under tension by means of Bitter patterns. C. GREINER. *Ann. Phys.* [*Leipzig*] **16**, *No.* 3–4, 176–80 (1955) In German.

The experiments show that the nuclei originate at crystal grain boundaries. E. P. WOHLFARTH

538.221

9765. Multipolarization in the hexagonal barium iron oxide magnets. B. KUBOTA AND C. OKAZAKI. Note in *J. Phys. Soc. Japan*, **10**, *No.* 8, 723 (*Aug.*, 1955).

After appropriate magnetic annealing a rod-shaped specimen was found to be divided into regions of magnetization alternately parallel and antiparallel to the axis of the rod. E. P. WOHLFARTH

538.221

9766. Antiferromagnetic resonance in hydrated copper chloride at 32 000 MHz. H. J. GERRITSEN, R. OKKES, B. BÖLGER AND C. J. GORTER. *Physica*, **21**, *No.* 8, 629–38 (*Aug.*, 1955).

Antiferromagnetic resonance was studied in single crystals of $CuCl_2 . 2H_2O$ at a frequency of 32 000 Mc/s and temperatures from 1·35° to 4·3°K. The constant field was applied along different directions in the *ab*- and the *ac*-plane. One of the resonances observed occurred on the threshold hyperbola and had a width of only 15 Oe at the lowest temperature. Other resonances permitted the determination of the parameters: H_c, H_a and α, which characterize respectively: the anisotropy of the exchange field in two directions and the anisotropy of the susceptibility. On the whole the agreement with the earlier data at 9 400 Mc/s and with the theoretical expectations of Ubbink and Yosida is excellent. Below about 2·5°K a so far unexplained structure of certain resonances was observed. A few data are given on the *g*-values and widths of the paramagnetic resonance above the Néel temperature. A.

538.221

9767. On the interpretation of some data obtained with antiferromagnetic resonance in hydrated copper chloride. H. J. GERRITSEN. *Physica*, **21**, *No.* 8, 639–50 (*Aug.*, 1955).

The theories of Ubbink [Abstr. 2573 (1954)] and Yosida [Abstr. 3423 (1953)] are compared with the experiments on $CuCl_2 . 2H_2O$ at 32 000 Mc/s. Within the accuracy of the experiments a complete agreement has been found with these theories; the experiments gave the values: $H_c = 6\,500$ Oe and $H_a = 9\,150$ Oe. The temperature dependence of αH_c^{*2} is compared with $\overline{M}^2(T)$, based on the molecular field theory. The general behaviour of the resonance fields as a function of temperature is discussed. A.

538.221

9768. Measurement of susceptibility tensor in ferrites. J. O. ARTMAN AND P. E. TANNENWALD. *J. appl. Phys.*, **26**, *No.* 9, 1124–33 (*Sept.*, 1955).

Experimental techniques for measuring the magnetic

susceptibility tensor components in microwave cavities are described. General expressions for the perturbation of microwave cavities by the magnetic properties of ferrites are developed. Experimental results are given for Ferramic 1331 measured at 9165 Mc/s. Since these results indicate that both the real and imaginary parts of the tensor components χ and κ are approximately equal to each other in the resonance region, only measurement of the diagonal components may suffice to specify the complete tensor. However, whenever the small differences between χ and κ are desired, measurement of the tensor susceptibility in a degenerate cavity will be necessary. An attempt has been made to compare the experimental results with the Bloch–Bloembergen magnetic resonance theory as applied to circularly polarized excitation. A.

538.221 : 536.424

9769. On disappearance of the Hopkinson effect. Y. TINO. *J. Sci. Res. Inst.* [*Tokyo*] **49**, 97–102 (*March*, 1955).

In some Fe–Ni alloys the magnetization-temperature curve obtained either in weak fields or in high fields, takes a peculiar shape that is characterized by a monotonic decrease of magnetization with rising temperature. Such alloys are, more or less, inherent mixtures of two phases ($\alpha + \gamma$), which are, however, in a state of very fine dispersion; in general, they do not show two-phase character, as seen in the magnetization-temperature curve; thus, they might be regarded as in a transition state. These circumstances were studied experimentally, and suggestions made for solving the various anomalies in the Fe–Ni system as well as for analysing the general mechanism of phase transformation. A.

538.221 : 538.245

9770. On an empirical formula for the ferromagnetic anisotropy constant in cubic crystals. M. YAMAMOTO. Note in *J. Phys. Soc. Japan*, **10**, *No.* 8, 725–6 (*Aug.*, 1955).

Shows that an empirical relation $|K| = \frac{1}{4}I_0H_s$, where I_0 is the saturation magnetization and H_s the field required to obtain about 99·8% of saturation for a polycrystalline specimen, gives good agreement with measured values for Ni–Co and Ni–Cu alloys.

E. P. WOHLFARTH

538.221 : 539.31

9771. A magnetic internal friction peak in nickel under alternating magnetic field. K. MÍŠEK. *Scientia Sinica*, **4**, *No.* 1, 107–18 (*March*, 1955).

The coupling between elastic and magnetic phenomena in ferromagnetic materials often gives rise to internal friction. In previous studies on magneto-elastic internal friction, the applied magnetic field was mostly static. In the present experiment, a nickel specimen was made to vibrate in torsion under an alternating magnetic field, and a pronounced internal friction peak was observed when internal friction was plotted as a function of the alternating magnetic field strength. This peak did not appear under similar conditions but using a static magnetic field. The position of the peak was shifted toward the side of higher magnetic field when the nickel specimen was either cold-worked or contained carbon; and it was shifted toward the side of lower magnetic field when the specimen was previously annealed at an elevated temperature. The height of the peak was considerably raised with an increase of vibrating frequency. A qualitative explanation of this peak is given on the basis of reversible and irreversible processes occurring at different stages of the magnetization curve of nickel. Factors affecting this peak are discussed. A.

538.221 : 669.018.588.4 : 621.318.1

9772. Evaporated magnetic materials. M. S. BLOIS, JR. *Electronics*, **28**, *No.* 6, 210, 212, 214, 216, 218 (*June*, 1955).

Glass, ceramic or other forms to be coated are placed in a vacuum chamber with a crucible of magnetic alloy and another of dielectric (MgF_2). Coils are placed round each crucible for induction heating and are energized alternately, so that alternate very thin layers of alloy and dielectric are deposited on the forms. This results in almost complete elimination of eddy current loss and gives better control of the hysteresis loop. [See also Abstr. 8311 (1955).]

W. G. STRIPP (R)

538.222

9773. Temperature dependence of the magnetic susceptibility of sodium and potassium. K. VENKATESWARLU AND S. SRIRAMAN. Letter in *Curr. Sci.*, **24**, *No.* 6, 191–2 (*June*, 1955).

Reports results of measurements between room temp. and 120°C, including the melting points. The room temp. values of the mass susceptibility were found to be $0{\cdot}575$ and $0{\cdot}455\times10^{-6}$ for Na and K respectively. With increasing temperature the susceptibility increases slightly up to the melting point and then decreases abruptly by a small amount.

E. P. WOHLFARTH

538.222

9774. A note on the paramagnetic relaxation. M. YOKOTA. *J. Phys. Soc. Japan*, **10**, *No.* 9, 762–8 (*Sept.*, 1955).

Introducing the spin–spin relaxation time in Bloch's equation simultaneously, the author has calculated the relaxation equation of paramagnetic substances. As the contribution from the spin–spin relaxation to the imaginary part of the complex susceptibility, a term proportional to $(1 - F)^2$ instead of $(1 - F)$ given by Broer has been obtained. The theory explains the experimental results obtained by Gorter *et al.* for the dependence of the spin–spin relaxation time on the static field strength. A.

538.222

9775. Proton magnetic resonance of the CH_3 group. III. Reorientation mechanism in solids. J. G. POWLES AND H. S. GUTOWSKY. *J. chem. Phys.*, **23**, *No.* 9, 1692–9 (*Sept.*, 1955).

For Pt II, see Abstr. 1464 (1954). The proton magnetic resonance absorption has been reported to change with temperature in a manner suggesting hindered C_3 rotational motions of the CH_3 groups in several solid compounds. In this paper, the reorientation mechanism is considered more closely. The second moments of the absorption lines are calculated as a function of temperature for three types of motion. Similar predictions are obtained for two classical models, a Brownian type rotation by random angles

and a random jumping between fixed positions $2\pi/3$ apart. The results are different for the third model, a quantum-mechanical tunnel effect, for which approximate calculations are given. The experimental data for methyl chloroform, 2, 2-dinitropropane, and 2-chloro-2-nitropropane can be fitted either to a classical model or to the tunnel effect by adjusting the potential barrier to the reorientations. However, the activation energies for classical rotation are low, about 2·2 kcal. mole^{-1} and the observed frequency factors of 10^7 are unexplained. The tunnel effect gives larger barriers, about 5 kcal, and the predicted frequency factors agree well with experiment. In the case of 2, 2-dichloropropane a classical motion is indicated by the large frequency factor of 10^{12}. A.

538.222

9776. Magnetic properties of uranium hydride. D. M. GRUEN. *J. chem. Phys.*, **23**, *No.* 9, 1708–10 (*Sept.*, 1955).

The magnetic susceptibility of βUH_3 has been measured in the temperature range 191°K to 603°K. From the high-temperature portion of the χ^{-1} *v.* T curve a magnetic moment of 2·79 Bohr magnetons is calculated, with $\Delta = -137$°K. A ferromagnetic transition occurs in the neighbourhood of 173°K. Magnetic moment measurements made in the temperature range 63°K to 196°K in fields of 1 550 to 8 700 Oe can be extrapolated to yield a saturation magnetic moment of about one Bohr magneton. A.

538.222 : 536.48

9777. Further researches on the magnetic properties of potassium chromium alum below 1°K. J. A. BEUN, M. J. STEENLAND, D. DE KLERK AND C. J. GORTER. *Physica*, **21**, *No.* 8, 651–62 (*Aug.*, 1955).

A refinement of the ballistic method for measuring susceptibilities is described. With this method measurements on a sphere ground from a single crystal $CrK(SO_4)_2.12H_2O$ were made in constant external fields. The results are used to test a formula of Garrett for determining the absolute temperatures and to calculate the temperature variations along isentropics. The behaviour of the remanent magnetic moment in constant external fields was also studied. A.

538.24

9778. Reversible and irreversible magnetization changes along the hysteresis curve. M. KERSTEN. *Z. angew. Phys.*, **7**, *No.* 8, 397–407 (1955) In German.

A general review of the theory of the secondary domain structure, the coercive force and the initial permeability of ferromagnetic materials.

E. P. WOHLFARTH

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3

9779. Electromagnetic field equations for a moving medium with Hall conductivity. J. H. PIDDINGTON. *Monthly Not. Roy. Astron. Soc.*, **114**, *No.* 6, 638–50 (1954).

In an isotropically conducting medium the electric field and current density are associated by Ohm's law. This, together with Maxwell's equations, leads to

$$\nabla^2 \boldsymbol{H} = 4\pi\sigma\left[\frac{\partial \boldsymbol{H}}{\partial t} - \text{curl}\,(\boldsymbol{v}\times\boldsymbol{H})\right] + c^{-2}\frac{\partial^2 \boldsymbol{H}}{\partial t^2},$$

where $\boldsymbol{H}$, $\boldsymbol{v}$ and σ are the magnetic field, velocity of the medium and conductivity. This equation describes any electromagnetic field in a moving (or fixed) conductor. It includes the "telegraph equation" of radio waves and also describes any hydromagnetic wave. Ionized gas in a sufficiently strong magnetic field is anisotropically conducting and σ is replaced by a tensor. An equation analogous to the above is derived for these conditions, allowing the study of electromagnetic disturbances in a medium with Hall conductivity. The equation is used on some simple problems of astrophysical interest, including hydromagnetic waves. A.

538.3

9780. General theory of magnetic "charges" at rest and in movement. E. DURAND. *Rev. gén. Elect.*, **64**, *No.* 7, 350–6 (*July*, 1955) In French.

The first section demonstrates the equivalence of fictitious systems of magnetic charges and real systems of electric currents. The second section deals with moving magnetic "charges" and the electric field produced. Formulae are given permitting the calculation of electric fields and inductions produced by a moving magnet. A. E. DE BARR

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.56 : 532.5

9781. The motion of ionized gas in combined magnetic, electric and mechanical fields of force. J. H. PIDDINGTON. *Monthly Not. Roy. Astron. Soc.*, **114**, *No.* 6, 651–63 (1955).

Transient electric and mechanical forces uniform in space are applied to a gas in the presence of a steady magnetic field. The current transport equation for the anisotropically conducting medium is used to determine the subsequent motion of the gas, the internal electric field and the current density. These are damped oscillatory functions leading to a steady state. There is a close connection between the effects of the electric and mechanical forces: a steady internal electric field perpendicular to the magnetic field cannot exist unless accompanied by a mechanical force. The relationship between the two is examined. Neglect of this relationship has already proved fatal to many astrophysical theories. On the other hand, there seems little justification for treating mechanical forces as "equivalent electric fields," as is often done. This and a companion paper [Abstr. 9779 (1955)] appear to provide, for the first time, a satisfactory system for using transport equations in the study of dynamical problems in nearly uniform, anisotropically conducting gases. Such problems are proving increasingly numerous and important in astrophysics. A.

538.56 : 532.51

9782. Hydromagnetic disturbances in a fluid of finite conductivity. P. H. ROBERTS. *Astrophys. J.*, **122**, *No.* 2, 315–26 (*Sept.*, 1955).

A study is made of the equation governing the propagation of Alfvén waves in an unbounded fluid of finite electrical conductivity. Periodic and aperiodic solutions are derived, the latter of which are obtained by operational methods. A.

538.56 : 550.383.3 : 532.51 : 523.75

Hydromagnetic dynamo models. *See Abstr.* 9372

538.565

9783. Velocity distribution of electrons in the presence of an alternating electric and constant magnetic field. V. M. FAĬN. *Zh. éksper. teor. Fiz.*, **28**, *No.* 4, 422–30 (1955) In Russian.

The distribution function is found for two cases of varying electric field: harmonic dependence on time; amplitude-modulated sine wave. The physical situation is that of elastic collisions between electrons and an atomic gas. Inter-electron collisions are neglected. S. C. DUNN

538.566

9784. Reflection of a plane electromagnetic wave from an ionized medium. P. POINCELOT. *C.R. Acad. Sci.* [*Paris*] **241**, *No.* 2, 186–8 (*July* 11, 1955) In French.

Expressions are given for the amplitudes of the transmitted and reflected fields, together with a formula for the reflection coefficient for a plane wave incident on the boundary between free space and an ionized medium. G. D. SIMS

538.566

9785. Reflection of a plane electromagnetic wave from an ionized gas following a certain law. P. POINCELOT. *C.R. Acad. Sci.* [*Paris*] **241**, *No.* 3, 290–2 (*July* 18, 1955) In French.

An extension of the results of the preceding abstract. It is shown that for a wave entering an ionized layer whose refractive index varies with height, a critical layer thickness exists for which total reflection occurs at the upper surface. G. D. SIMS

538.566 : 621.372.8

9786. Propagation of plane electromagnetic waves in space filled with plane parallel lattices. A. M. MODEL'. *Radiotekhnika*, **10**, *No.* 6, 52–7 (1955) In Russian.

Formulae are derived for propagation constant, refractive index, reflection and transmission coefficients for an artificial dielectric consisting of an assembly of plane parallel arrays of elements. The essential approximation made is that the component fields due to currents flowing in the lattice elements are merely plane. The properties of an infinite or finite assembly of arrays are deduced from the properties of a single lattice by writing down and solving the equations for the field at each lattice in terms of all the transmitted and reflected partial waves. S. C. DUNN (R)

538.566 : 535.42 : 534.26

A theory of the diffraction of a scalar wave by a plane screen. *See Abstr.* 9506

538.566 : 621.396.11

9787. Maximum transmission of electromagnetic waves by a pair of wire gratings. G. VON TRENTINI. *J. Opt. Soc. Amer.*, **45**, *No.* 10, 883–5 (*Oct.*, 1955).

Specifications of the approximate equations for a pair of parallel wire gratings spaced at maximum transmission are treated. Measurements with microwaves were made, and the separation of gratings as well as the phase shift, at peak transmission, determined for various angles of incidence and compared with calculated values. A.

538.566 : 621.396.677.85

9788. Conflection doublets. G. TORALDO DI FRANCIA. *J. Opt. Soc. Amer.*, **45**, *No.* 8, 621–4 (*Aug.*, 1955).

Some very simple configuration lenses for high-speed scanning are investigated with the standard methods of optical design. The correction for spherical aberration is achieved by combining a convergent and a divergent element in much the same way as is done in optics. The resultant lens is a doublet. The term *conflection* of a ray is proposed for the change of direction which the ray shows at a sharp bend of the lens surface. A.

538.566 : 621.396.677.85

9789. Geometrical optics of toroidal junctions in configuration lenses. L. RONCHI. *Optica Acta*, **2**, *No.* 2, 64–80 (*July*, 1955).

The geometrical behaviour of toroidal junctions between conical coaxial surfaces is analysed. It is found that these junctions behave like lenses, and generally like thick lenses. The exact geometrical behaviour of lenses of this type is determined and also the location of their principal points and the third-order spherical aberration. Graphs and tables of numerical data are given for the particular case in which the image-cone is reduced to a disk. A.

538.566.2

9790. The four possible waves in a magneto-ionic medium. J. H. PIDDINGTON. *Phil. Mag.*, **46**, 1037–50 (*Oct.*, 1955).

It is well known that several different types of waves may be transmitted through a magneto-ionic medium; that is, ionized gas permeated by a steady magnetic field. Foremost is the pair of radio waves whose properties are so well described by the "magneto-ionic theory" of Appleton and others. More recently several hydromagnetic (or magnetohydrodynamic) waves have been studied. A "plasma" or electron-pressure wave has received little attention except in the simple case of zero magnetic field. Finally there are sound waves which may propagate in any gas. The relationship between these various waves is disclosed: the magneto-ionic medium is quadruply refracting, transmitting four, and only four, different waves. The hydromagnetic ordinary and extraordinary waves are identical with the radio *O* and *E* waves, the latter being the simple limiting case of the former when heavy ion motion is negligible. The other two waves comprise a "magnetic sound" wave (a type of hydromagnetic wave) and a "magnetic plasma" (*P*) wave. The *P* wave is discussed in some detail, using transport equations. Its velocity and polarization are determined within certain ranges and its spontaneous growth and decay are considered. Examples of *P* waves in the solar atmosphere are given. If, as seems probable, these waves can grow, then they may cause the *O* and *E* waves to grow and

so provide an explanation of non-thermal solar radio noise. The effect of electron pressure on the *O* and *E* waves is determined quantitatively. A.

538.566.2

9791. On the propagation of the electromagnetic waves in an inhomogeneous atmosphere. Y. NOMURA AND K. TAKAKU. *J. Phys. Soc. Japan*, **10**, *No.* 8, 700–14 (*Aug.*, 1955).

Rigorous solutions of Maxwell's equations in an inhomogeneous medium were obtained, and led to descriptions of the electromagnetic waves from a dipole source in the medium, where the inductive capacity is an arbitrary function of the distance from the centre of the earth sphere. The first approximation of these descriptions gives more abundant and complete results than those which have as yet been obtained by Fermat's principle of geometrical optics and leads to a satisfactory theory for the so-called super-refracted propagation in a layer called the duct. A.

538.566.2

9792. Analysis of sky-wave field intensity. II. S. N. MITRA AND R. B. L. SRIVASTAVA. *Indian J. Phys.*, **29**, *No.* 5, 227–42 (*May*, 1955).

In Pt I [Abstr. 8941 (1955)] a statistical analysis of the field intensity of the internal short-wave stations of All India Radio over the period of a complete solar cycle (1942–52) was given. The results are now compared with theoretical deductions. It has been pointed out that the theoretical methods are not strictly applicable to the calculation of sky-wave field intensity as observed in tropical countries. A modified method applicable to tropical conditions has yet to be developed. A.

538.566.2

9793. The influence of the earth's magnetic field on the propagation of long electric waves. W. O. SCHUMANN. *Z. angew. Phys.*, **7**, *No.* 6, 284–90 (1955) In German.

The previous work [Abstr. 6155 (1953), 1498, 6744, 8455, 10358 (1954) and 412B (1955); *Z. angew. Phys.*, **6**, *No.* 8, 346–52 (*Aug.*, 1954)] is extended by considering the ionosphere to behave as an anisotropic conductor in the presence of the earth's magnetic field. J. M. HOUGH

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11 : 539.2

9794. Elementary course in solid state physics. W. H. BESSEY. *Amer. J. Phys.*, **23**, *No.* 7, 410–12 (*Oct.*, 1955).

Engineering educators are becoming very interested in solid state physics. A course is described which is designed for seniors and beginning graduate students in both physics and engineering. Some of the difficulties in the choice of textbook and subject matter are pointed out, difficulties due in large part to the lack of background of the students. A selected bibliography, with comments, is given in the appendix. A.

539.11 : 548.7

The structure of ice. *See Abstr.* 10067

539.11 : 537.312.62 : 534.23

Ultrasonic attenuation in metals. *See Abstr.* 9499

539.11 : 548.7

Vacancy migration and disorder-order transformations in alloys. *See Abstr.* 10069

MOLECULES 539.13

539.13

9795. Intermolecular potentials of argon, krypton, and xenon. E. WHALLEY AND W. G. SCHNEIDER. *J. chem. Phys.*, **23**, *No.* 9, 1644–50 (*Sept.*, 1955).

The intermolecular potentials of argon, krypton and xenon are investigated using the recently measured second virial coefficients and the crystal properties at 0°K. The potential functions considered are the 9 : 6, 12 : 6 and exp : 6. The methods of determination of parameters are reviewed and the method of least squares used in this paper described. All the potentials fitted the second virial coefficient very well, but with the same parameters fitted the crystal properties only moderately well. A.

539.132 : 539.153.4 : 539.181

9796. Resonance transitions in molecular beam experiments. I. General theory of transitions in a rotating magnetic field. H. SALWEN. *Phys. Rev.*, **99**, *No.* 4, 1274–86 (*Aug.* 15, 1955).

The time-dependent Schrödinger equation is solved formally for an atomic or molecular system which is subjected simultaneously to a rotating magnetic field of constant amplitude and angular velocity and to a constant magnetic field along the axis of rotation. The method yields the transition probabilities in terms of the solutions to an eigenvalue problem. This eigenvalue problem is solved both for (*a*) a normal Zeeman effect and for (*b*) the case where a transition from a given level is isolated in frequency from other transitions from the same level. Case (*a*) is exactly soluble and yields a solution which is shown to be the same as that of Bloch and Rabi, but is in a form which is more convenient for integration over the velocity distribution. Case (*b*) must be solved by an approximate method which results in a prediction of multiple quantum transitions as observed by Kusch. A.

539.132

9797. Bending force constant of the carbon tetrafluoride molecule. E. AIHARA. Letter in *J. chem. Phys.*, **23**, *No.* 8, 1563–4 (*Aug.*, 1955).

The change δE during a vibration (ν_2) in which the C–F distances are unaltered has been calculated. Slater atomic orbitals were used each satisfying the Hartree equation; nonorthogonality between paired orbitals was taken into account. The result $\frac{1}{2}(\partial^2 E/\partial\theta^2)_{\theta=0} = 37\,\text{eV}$ is considered good compared with the experimental 49·3 eV. J. JACOBS

539.132

9798. Force constants, infrared spectrum, and thermodynamic properties of $TiCl_4$. N. J. Hawkins and D. R. Carpenter. *J. chem. Phys.*, **23**, *No.* 9, 1700–2 (*Sept.*, 1955).

The spectrum of gaseous titanium tetrachloride was obtained in the rock salt and potassium bromide regions of the infrared. The thermodynamic functions C_p^0, S^0 and $-(F^0 - E_0^0)/T$ were calculated. The orbital valence force field constants were computed, and lead to the conclusion that hybridization changes may be significant in the F_2-vibrations. A.

539.132

9799. Perturbation method for the calculation of molecular vibration frequencies. II. Generalization of the theory. P. W. Higgs. *J. chem. Phys.*, **23**, *No.* 8, 1448–50 (*Aug.*, 1955).

The perturbation theory developed previously [Abstr. 7002 (1953)] for calculating frequencies by Wilson's F and G matrix method is now generalized in two respects: the effects, on the one hand, of degeneracy amongst the approximate frequencies and, on the other, of interaction constants coupling the two classes of vibration are considered. A.

539.132

9800. Perturbation method for the calculation of molecular vibration frequencies. III. Skeletal stretching vibrations of normal paraffins. P. W. Higgs. *J. chem. Phys.*, **23**, *No.* 8, 1450–3 (*Aug.*, 1955).

The perturbation theory developed in a previous paper [Abstr. 7002 (1953)] is applied to the skeletal vibrations of the zigzag configuration of the *n*-paraffins. By treating the CCC bending force constant as small compared with the CC stretching force constant the first-order correction to the stretching frequencies is obtained in closed form. It is compared with the corresponding term in the Kirkwood–Fitzer formula for the frequencies of long-chain paraffins. A.

539.132 : 535.338.4

Computation of intensities of vibrational spectra of electronic bands in diatomic molecules. *See Abstr.* 9556

539.132 : 535.343

Deformation frequencies of the NH_3 ligand. *See Abstr.* 9568

539.132 : 536.633

Barrier height and thermodynamic functions of gaseous HNO_3 and DNO_3. *See Abstr.* 9619

539.132 : 548.7

9801. A method for calculating thermal vibration amplitudes from spectroscopic data. P. W. Higgs. *Acta cryst.*, **8**, *Pt* 10, 619–20 (*Oct.*, 1955).

It is shown how $(\bar{u}_i^2)_{\text{int.}}$ the contribution from internal molecular vibrations to the mean square amplitude of thermal motion of an atom in a molecular crystal, may be calculated from the vibrational spectrum of the molecule itself and that of a molecule which differs from it only by the occurrence of a different isotope at position i. A.

539.132

9802. Complete π-electron treatment of allyl radical and allyl ion. H. C. Lefkovits, J. Fain and F. A. Matsen. *J. chem. Phys.*, **23**, *No.* 9, 1690–2 (*Sept.*, 1955).

The wave-functions for the allyl radical and ion are linear combinations of all independent antisymmetrized products of π-electron wave-functions. The ground-state energy of the radical is $3W_{2p} - 28{\cdot}963$ eV and of the ion $2W_{2p} - 30{\cdot}471$ eV. Setting $-W_{2p}$ equal to the ionization energy of methyl, the ionization energy of allyl is calculated to be $8{\cdot}44$ eV, compared to an experimental value of $8{\cdot}16$ eV. The resonance energy of the ion is calculated to be $\sim 1{\cdot}50$ eV greater than that of the radical. An experimental comparison based on methyl and neglecting some compression energy is $\sim 1{\cdot}70$ eV. A.

539.132 : 541.64

9803. Proton magnetic resonance in polyamides. W. P. Slichter. *J. appl. Phys.*, **26**, *No.* 9, 1099–104 (*Sept.*, 1955).

The proton magnetic resonance absorption has been observed in several linear polyamides from 77°K to 400°K. The absorption line narrows gradually with increasing temperature up to about 280°K. A marked decrease in line width with increasing temperature occurs over a span of 20 or 30 degrees within the range of 280 to 400°K, and is presumed to result from the onset of rotation of chain segments. In a series of polyamides possessing an even number of carbon atoms between polar groups, this transition occurs at a lower temperature as the hydrocarbon portions are made longer (polydecamethylene octadecanediamide compared to polyhexamethylene adipamide). In the copolymer polyhexamethylene adipamide-sebacamide, the transition region is at a lower temperature than in the pure adipamide or pure sebacamide. The X-ray diffraction studies on polyamide fibres show that the chain packing becomes more symmetrical over these same temperatures. The resonance results are interpreted in terms of simple models. A.

539.132

9804. Nuclear magnetic resonance: structure of the amino group. I. R. A. Kromhout and W. G. Moulton. *J. chem. Phys.*, **23**, *No.* 9, 1673–9 (*Sept.*, 1955).

Line widths and second moments of the proton magnetic resonance absorption line of ten amines, amides and amino acids have been measured. It is shown that hydrogen bonds in the amides and amino acids strongly affect the structure. New evidence for the existence of glycine in the dipolar form in the solid state is presented. The N — H bond distances in urea and glycine are calculated from observed second moments and are found to be $1{\cdot}077 \pm 0{\cdot}007$ Å and $1{\cdot}074 \pm 0{\cdot}014$ Å, respectively. The bond angles of the amino group are assumed tetrahedral in both cases in making the calculation. A.

539.132

9805. Return to the effect of the chemical bond on electron density. S. Besnainou, M. Roux and R. Daudel. *C.R. Acad. Sci.* [*Paris*] **241**, *No.* 3, 311–13 (*July* 18, 1955) In French.

Normally the chemical bond corresponds to a trough in C. However, for Li_2, using Coulson's wave-functions, a maximum of C is associated with the bond. This is further examined and is found to

become reduced if the bond is shortened. It may be due to the weakness of this bond. J. JACOBS

539.132

9806. Some remarks on the structure of NH_3 and PH_3 molecules. W. KOŁOS. Letter in *J. chem. Phys.*, **23**, *No.* 8, 1554 (*Aug.*, 1955).

Using the method of equivalent orbitals the variation with bond angle of the total energy is calculated. C. TURNER

539.132

9807. Natural spin-orbitals for helium. H. SHULL AND P.-O. LÖWDIN. Letter in *J. chem. Phys.*, **23**, *No.* 8, 1565 (*Aug.*, 1955).

The ground state is investigated using Laguerre functions as (*ns*) orbitals. Using $n = 1, 2, 3$ the best spatial wave-function is formed by a superposition of configurations. This is analysed in terms of natural spin-orbitals. The first NSO is related to the Hartree SCF function but obtained linearly; the corresponding energy being −2·861 335. J. JACOBS

539.132

9808. The electron withdrawal power of substituent groups. B. P. DAILEY AND J. N. SHOOLERY. *J. Amer. Chem. Soc.*, **77**, *No.* 15, 3977–81 (*Aug.* 5, 1955).

A study of chemical shifts in the nuclear magnetic resonance spectra of ethyl and methyl derivatives of a number of organic substituent groups has been made. It was desired to find out how the electronegativity of an atom changes when it forms a part of different substituent groups and to attempt to derive a table of the electron withdrawal power of the substituent groups. A simple relationship between proton "chemical shifts" and the ionic character of the chemical bond to the proton has been established by the regularities existing in the experimental results of this study. It is shown that the electron withdrawal power of a substituent group is largely determined by the electronegativity of the first atom in the group. A.

539.132

9809. Energy calculations of multiple hydrogen-atom systems by VB and MO methods. R. S. BARKER, R. L. SNOW AND H. EYRING. *J. chem. Phys.*, **23**, *No.* 9, 1686–9 (*Sept.*, 1955).

The equivalence of complete valence bond (VB) and of total configuration interaction molecular orbital (CIMO) methods has often been discussed. The two methods give identical expressions for H_2. Treatment of H_2 by the method of Coulson and Fischer also gives the same result. An extension of this method of semi-localized orbitals to the H_3^+ and H_3 systems is attempted and found to be unsatisfactory. This indicates that a single configuration treatment, however general the molecular orbitals may be, is a poorer approximation than either the extended VB or CIMO treatments. R. Taylor's exact integral (LCI) molecular orbital treatment for linear H_4 is compared with the exact integral covalent bond (HL) method. A single structure of the latter method gave a ground-state energy of −57·02 eV while the two covalent structure treatment gave −58·59 eV. An energy of −55·64 eV is reported by Taylor using the best single MO configuration while he found an energy of only −56·40 eV using six of twelve possible MO ground-state configurations. It appears in view of the equivalence of the refined forms of the two treatments that the omitted higher energy configurations contribute more strongly to the ground-state energy than the lower energy ones. This indicates that low energy is not a good criterion for inclusion of configurations in a limited configuration interaction treatment. Recent work by A. Pullman on butadiene supports this conclusion. A.

539.132

9810. On the basis of orbital theories. R. MCWEENY. *Proc. Roy. Soc. A*, **232**, 114–35 (*Oct.* 11, 1955).

In molecular theory the wave-function is usually constructed from antisymmetrized products, or "Slater determinants," of one-electron "orbitals." A single determinant of suitably chosen, doubly occupied orbitals is often a fair approximation to a singlet ground state; but when more general products are admitted, as in "configuration interaction" calculations, it is first necessary to resolve a high "spin degeneracy" by constructing spin eigenfunctions (SE's). The fundamental basis of recent methods is clarified by a group theoretical approach. The energy expression, using as wave-function an arbitrary mixture of similar SE's, is written very simply in terms of the reduced density matrices for one and two particles, and formulae for the calculation of these matrices are given. The remaining problem is to get a "best" wave-function, usually with limited configuration interaction, by (i) variation of SE coefficients and (ii) variation of the orbitals appearing in the SE's, and this problem is formally solved. (i) is the usual configuration interaction process; but (ii) is new and leads, when the orbitals are expressed in terms of a standard basic set (e.g. of atomic orbitals), to a complete generalization of the Roothaan (1951) equations. These (matrix) equations are simple in appearance, but their numerical solution calls for new techniques; and it is possible that the Roothaan (i.e. Hartree–Fock) approach, followed by configuration interaction, provides about the best working compromise between (i) and (ii). Some points of contact between one- and many-configuration theories are noted. In particular, certain density matrix elements provide appropriate generalizations of the "charges" and "bond orders" of Coulson and Longuet-Higgins and continue to describe the response of a system to changes in its "Coulomb" and "resonance" integrals. A.

539.132 : 539.133

9811. Bond energies, internuclear distances, and force constants in series of related molecules. H. O. JENKINS. *Trans Faraday Soc.*, **51**, *Pt* 8, 1042–4 (*Aug.*, 1955).

For series of related molecules, even though constancy of bond type is not maintained, it is suggested that bond energy varies with the inverse of the square of the equilibrium internuclear distance. A.

539.133

9812. The calculation of the electrical potential in the neighbourhood of a molecular dipole surrounded by ions. J.-E. DUBOIS AND J. BARTHEL. *C.R. Acad. Sci.* [*Paris*] **241**, *No.* 2, 201–3 (1955) In French.

A general expression is derived describing the

behaviour of "real" dipoles in the interior of a molecular sphere. The equation obtained reduces simply to the expression calculated by Amis and Jaffe for "point" dipoles. P. CUCKA

539.133

9813. Hybridization and dipole moment. J. H. GIBBS. *J. phys. Chem.*, **59**, *No.* 7, 644–9 (*July*, 1955).

Orbital hybridization, as determined by bond angle, can account for the major variations in electric dipole moment among the hydrides and organic derivatives of vertical series of non-metallic elements of the periodic system. This is shown by calculation of the moments of purely covalent forms of such compounds. A.

539.133

9814. *r*-Centroids for diatomic molecules. R. W. NICHOLLS AND W. R. JARMAIN. Letter in *J. chem. Phys.*, **23**, *No.* 8, 1561 (*Aug.*, 1955).

Hitherto *r*-centroids have been used to examine the variation with internuclear separation of the transition moment. It is further shown that the expectation values $\bar{r}_{v'}$ and $\bar{r}_{v''}$ are weighted averages of *r*-centroids w.r.t. the Franck–Condon factors. J. JACOBS

539.133

9815. Intramolecular O–H–O hydrogen bonds in bis (dimethylglyoximate) cobalt(III) complexes. J. FUJITA, A. NAKAHARA AND R. TSUCHIDA. Letter in *J. chem. Phys.*, **23**, *No.* 8, 1541–2 (*Aug.*, 1955).

Infrared spectra of several complexes show similar O–H stretching frequencies to the nickel complex [Abstr. 1010 (1953)], which is evidence for a planar co-ordination of the dimethylglyoximate ions. C. TURNER

539.133 : 535.343

Structure of cyclopropane-d_6. *See Abstr.* 9565

539.133

9816. Excluded volume in polymer chains. M. FIXMAN. *J. chem. Phys.*, **23**, *No.* 9, 1656–9 (*Sept.*, 1955).

A perturbation theory of the excluded volume effect in chain polymers is developed. The theory is applied to the mean square end-to-end distance, $\langle L^2 \rangle$, of a linear chain (second-order perturbation), and to the mean square radius of a linear and a branched chain (first-order perturbation). Flory's approximate theory is found to be in fair agreement with the second-order perturbation theory. Integro-differential equations are developed to discuss the behaviour of $\langle L^2 \rangle / nb^2$ as $n \to \infty$, for a chain composed of n segments of length b. A.

ATOMS . NUCLEUS . ISOTOPES 539.15

539.152 : 539.16 : 539.17

9817. CERN, the European Council for Nuclear Research. E. AMALDI. *Nuovo Cimento Suppl.* (*Ser.* 10) **2**, *No.* 1, 339–54 (1955).

The purposes and history of the CERN project are given briefly, and the present financial and legal position described. Sources of income and staff are given and the general layout of the chosen site near Geneva indicated. A list is provided of all accelerators built or known to be planned in Western Europe for energies over 100 MeV. J. H. FREMLIN

539.152.1

9818. On the explanation of the width of nuclear γ-resonances. K. WILDERMUTH. *Z. Naturforsch.*, **10a**, *No.* 6, 447–50 (1955) In German.

Within the framework of the Jensen–Steinwedel [Abstr. 1231 (1951)] model, the energy-width of nuclear γ-resonances can be explained by collisions between protons and neutrons in the nucleus. A. O. STANESBY

539.152.1

9819. On the collective rotational motion of the nucleus. II. R. NATAF. *C.R. Acad. Sci.* [*Paris*] **241**, *No.* 1, 31–3 (*July* 4, 1955) In French.

An examination of the properties of the Hamiltonian transformed according to the method described in Pt I [Abstr. 8988 (1955)]. P. T. MATTHEWS

539.152.1

9820. Observations on the charge and mass distributions in nuclei. O. MIYATAKE AND C. GOODMAN. Letter in *Phys. Rev.*, **99**, *No.* 3, 1040–2 (*Aug.* 1, 1955).

The large discrepancies, which arise between the quadrupole moments calculated from electrical excitation and from the energy of first excited states using the Bohr–Mottelson theory, may be accounted for by assuming different mass and charge distributions in the nucleus with different distortions. P. T. MATTHEWS

539.152.1

9821. Neutron and proton distributions in heavy nuclei. R. G. P. VOSS AND R. WILSON. Letter in *Phys. Rev.*, **99**, *No.* 3, 1056–7 (*Aug.* 1, 1955).

The inelastic cross-sections for 134 MeV protons and 140 MeV neutrons interacting with a series of nuclei are discussed theoretically. At these energies the elementary n, p cross-section is larger than the p, p or n-n cross-sections, and so the proton nuclear cross-sections are more sensitive to the neutron distributions in the nuclei, and vice versa. The data support the idea that the neutrons in heavy nuclei are spatially more extended than the protons. J. M. CASSELS

539.152.1

9822. On the interpretation of nuclear resonance fluorescence experiments. J. D. JACKSON. Letter in *Canad. J. Phys.*, **33**, *No.* 9, 575–6 (*Sept.*, 1955).

Attention is drawn to the frequent use of an incorrect formula, resulting in overestimation of γ-ray partial mean lifetimes. J. J. WILKINS

539.152.1

9823. The low energy nuclear mechanics and the independent particle model. A. KIND. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 3, 443–9 (*Sept.*, 1955).

The independent particle model of the nucleus is analysed in its definition as an approximation to weak incoherent interaction and its applicability to general problems of low energy nuclear mechanics. In zero approximation, defined by a condition of self-consistency, the potential wells which determine the states of the single nucleons in the nucleus have a mean depth of the order of twice the mean potential

energy per nucleon. It results, for instance, that direct emission and evaporation processes of nucleons have different thresholds. It is emphasized that the optical model for nuclear reactions can be directly derived from the model considered. A.

539.152.1

9824. Lowest state of surface oscillation of O^{16} at 14·7 MeV. D. H. WILKINSON. *Phys. Rev.*, **99**, *No.* 5, 1347–51 (*Sept.* 1, 1955).

The strongly resonant absorption of γ-rays by O^{16} that is observed at an energy of 14·7 MeV in the reaction $O^{16}(\gamma, p)N^{15}$ is discussed. It is shown from consideration of the integrated cross-section of this resonance and from the angular distribution of the photoprotons that the absorption is most probably electric quadrupole in character. It is suggested that the state at 14·7 MeV may be the lowest state of surface oscillation of O^{16}. This hypothesis gives the correct angular distribution for the photoprotons and requires the values $C_2 = 56$ MeV, $B_2 = 1{\cdot}8 \times 10^{-49}$ g.cm^2 for the parameters describing the surface oscillation; these parameters are 2·0 times bigger and 2·3 times smaller than expectation based on the value of the nuclear surface tension and classical hydrodynamics, respectively; these departures are in the sense naïvely expected for a closed-shell nucleus. A.

539.152.1

9825. Intermediate coupling shell model for Be^9. J. B. FRENCH, E. C. HALBERT AND S. P. PANDYA. *Phys. Rev.*, **99**, *No.* 5, 1387–92 (*Sept.* 1, 1955).

Energy levels, nuclear moments and relative deuteron reaction cross-sections are calculated for Be^9 using a Rosenfeld central and a one-particle spin-orbit interaction. The level structure and the magnetic dipole moment are sensitive functions of the magnitude of the spin-orbit interaction. The best fit to the experimentally found spectrum is given at a value $a/K = 1{\cdot}7$ for the intermediate coupling parameter of Inglis and at $K = 1{\cdot}33$ MeV for the Slater integral parameter. The 2·43 MeV state, in particular, is predicted to be 5/2−. The observed magnetic moment is fitted either in extreme *jj* coupling or once again at $a/K = 1{\cdot}7$. Certain relative cross-sections in the reactions $B^{10}(n, d)Be^9$ and $B^{10}(p, d)B^9$ are calculated and found to be in agreement with experiment. A.

539.152.1

9826. Particle binding energies and the diffuseness of the nuclear boundary. A. E. S. GREEN. *Phys. Rev.*, **99**, *No.* 5, 1410–15 (*Sept.* 1, 1955).

The approximate eigenvalues for a spherical well with an exponentially diffuse boundary and with spin-orbit splittings are applied to the study of particle binding energies. If the A-value locations of the low velocity 3*s* and 4*s* maxima in the neutron cross-section surface are taken at $A = 55$ and $A = 150$, the general trends of experimental binding energies and experimental radii sharply restrict the degrees of diffuseness that can be allowed. It would appear that the general trends of both proton and neutron binding energies as well as their discontinuities can be accounted for if a diffuseness parameter (i.e. tail length to e^{-1} point divided by inner radius) is chosen which drifts gradually from $\delta = 0{\cdot}3$ for light nuclei to $\delta = 0{\cdot}2$ for heavy nuclei. The diffuseness parameter needed goes to somewhat smaller values ($\delta \sim 0{\cdot}13$) if the critical 4*s* A-value is taken at 170. For heavy elements the diffuseness of the potential well obtained here is comparable to the diffuseness of the nuclear charge distribution obtained in recent studies. A.

539.152.1

9827. Nuclear saturation: a generalized Hartree–Fock method. R. J. EDEN. *Phys. Rev.*, **99**, *No.* 5, 1418–20 (*Sept.* 1, 1955).

The Hartree self-consistent method is generalized to apply to a system with strong two-body correlations. The generalized Hartree method is shown to be equivalent to solving a self-consistent equation for the mutual interaction of two particles moving in average fields together with a Hartree–Fock variational problem. In this form the method is equivalent to, and provides a simple explanation of, the nuclear saturation procedure used by Brueckner, Levinson and Mahmoud. A.

539.152.1

9828. Wave functions for nuclear shell theory by a variation method. M. G. REDLICH. *Phys. Rev.*, **99**, *No.* 5, 1421–6 (*Sept.* 1, 1955).

A system of A nucleons with two-nucleon potentials $V(i, k)$ acting between each pair of them is taken as a model for the nucleus. A variation method for obtaining the best approximation to the wave function of this system as a linear combination of a given set of functions $\psi_1, \ldots \psi_q$, is presented. In view of the evidence for shell effects, each ψ_α is assumed to describe A identical particles moving in a central field V'. In general, the amplitudes of only a small number of ψ_α are large. For a central Gaussian interaction $V(i, k)$ and a harmonic oscillator potential V', this method can account for the binding energy of one neutron in O^{17}, but not for the total binding energy of O^{16}. The model is compared with a spectroscopic one for a double closed shell core plus outer nucleons. A.

539.152.1

9829. Interactions between configurations of three nucleons in the 1*d*, 2*s* shell. M. G. REDLICH. *Phys. Rev.*, **99**, *No.* 5, 1427–39 (*Sept.* 1, 1955).

Calculations for the nuclei with mass 19 were based on a shell model with harmonic oscillator wave functions, central Gaussian interactions between the three outer nucleons, and a single-particle operator which leads to the energy differences between $1d_{\frac{3}{2}}$, $2s_{\frac{1}{2}}$ and $1d_{\frac{5}{2}}$ levels observed in O^{17}. Energy matrices for all configurations of the 1*d*, 2*s* shell were calculated. Wave functions of four nuclear states were obtained. They lead to the observed ft value for the allowed unfavoured O^{19} β^--transition, as well as for the favoured Ne^{19} β^+-transition. Energy differences between 5/2+ and $\frac{1}{2}$+ states of F^{19} and ground states of O^{19} and F^{19} are correctly given. Disagreement with the measured energy of the $\frac{1}{2}$+ state of O^{19} and the magnetic moment of F^{19}, however, indicates that at least modifications of this model are necessary to obtain general agreement. A.

539.152.1

9830. Pairing in shell models. M. UMEZAWA. *Proc. Roy. Soc. A*, **232**, 88–104 (*Oct.* 11, 1955).

An *L-S* pairing shell model is proposed for light nuclei. Three types of shell model, that is, super

multiplet theory, *j-j* pairing scheme and the *L-S* pairing scheme are compared with respect to the decomposition procedure by group theory, and also are compared in connection with nuclear magnetic moments. It is very likely that in light nuclei the *L-S* pairing or an intermediate coupling between the *L-S* pairing and *j-j* pairing schemes is a very good approximation. A.

539.152.1 : 537.533.74

9831. Electron scattering on tungsten at 31, 40, and 60 MeV. R. W. PIDD AND C. L. HAMMER. *Phys. Rev.*, **99**, *No.* 5, 1396–400 (*Sept.* 1, 1955).

The cross-section for electron scattering by heavy nuclei is model-independent at energies below 60 MeV. The angular distributions of electrons scattered by tungsten at 31, 40 and 60 MeV are self-consistent and give a uniform-model radius equal to $(1{\cdot}18 \pm 0{\cdot}10)$ $A^{\frac{1}{3}} \times 10^{-13}$ cm. A.

539.152.1 : 537.533.74

9832. High-energy electron scattering and nuclear structure determinations. III. Carbon-12 nucleus. J. H. FREGEAU AND R. HOFSTADTER. *Phys. Rev.*, **99**, *No.* 5, 1503–9 (*Sept.* 1, 1955).

For Pt II, see Abstr. 9299 (1954). The elastic scattering peak in carbon-12 is accompanied by a number of additional peaks corresponding to inelastic scattering of electrons from the various excited levels of the carbon nucleus. Three levels have been investigated by this method and correspond to the three known states at 4·43 MeV, 7·68 MeV and 9·61 MeV. Angular distributions of the inelastically-scattered electrons have been obtained as well as the angular distribution of the elastically-scattered electrons. The angular distributions of the inelastic peaks fall off less steeply with angle than the elastic peak. By comparing the scattering from carbon with scattering from the proton, and using the theoretical value of the cross-section of electrons scattered from the proton, it is possible to obtain "absolute" values for the elastic and inelastic scattering cross-sections. From the elastic-scattering curve, information about the size and charge distribution in the carbon-12 nucleus may be derived. The charge distribution lies halfway between a Gaussian and a uniform model. The root mean square radius of the resultant charge distribution is $(2{\cdot}40 \pm 0{\cdot}25) \times 10^{-13}$ cm. A.

539.152.2

9833. The gyromagnetic ratio of the proton. F. KIRCHNER AND W. WILHELMY. Note in *Z. Naturforsch.*, **10a**, *No.* 7, 592–3 (1955) In German.

The ratio found in experiments in a magnetic field produced by an electromagnet without iron core is significantly greater than that measured previously [Abstr. 7441 (1950)]. The discrepancy might be caused by an incorrect conversion factor from int. ampere into abs. ampere. G. E. BROWN

539.152.2

9834. On the influence of an inhomogeneity in the high frequency field in nuclear magnetic resonance. H. PFEIFER. *Z. angew. Phys.*, **7**, *No.* 8, 389–91 (1955) In German.

The h.f. field inhomogeneity is shown theoretically not to influence the n.m.r. signal in the first approximation with either the stationary or the spin-echo technique. D. H. WHIFFEN

539.152.2

9835. On the relation between the relaxation times and the transition probabilities in nuclear resonance (magnetic and quadrupolar). I–II. F. LURÇAT. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 25, 2402–3 (*June* 20); *No.* 26, 2517–18 (*June* 27, 1955) In French.

I. A general discussion of the number and nature of the spin/lattice nuclear relaxation times for nuclei $I > 1/2$.

II. Application to $I = 1$ shows that if A_1, A_2 are the probabilities for $\Delta m = \pm 1$, ± 2 then $T_1^M = 1/(A_1 + 2A_2)$ and $T_1^Q = 1/(3A_1)$ are the relaxation times for nuclear resonance and quadrupole resonance respectively. For $I = 3/2$ there are three relaxation times and the two T_1^M involve the octupole coupling. D. H. WHIFFEN

539.152.2 : 536.48 : 539.162

9836. Low-temperature nuclear orientation and its applications. H. HALBAN. *J. Phys. Radium*, **16**, *No.* 7, 609–14 (*July*, 1955) [*"Electron cloud role" colloquium*, see Abstr. 9842] In French.

A number of methods of orienting nuclei have been conceived so far. They lead either to polarization or to alignment. Two of them have already led to successful experiments. They both obtain orientation through magnetic h.f.s. fields in paramagnetic substances. Radioactive nuclei oriented in this way show anisotropic emission of γ-rays. A study of the anisotropy allows the multipole character of the γ-ray transition to be determined. The determination of the plane of polarization makes a distinction between magnetic and electric multipoles possible. In certain cases one can also determine the character of a β-ray transition preceding the emission of γ-rays. Future possibilities are discussed. A.

539.153.4

9837. Note on the present state of the theory of the electron cloud. R. DAUDEL. *J. Phys. Radium*, **16**, *No.* 7, 503–8 (*July*, 1955) [*"Electron cloud role" colloquium*, see Abstr. 9842] In French.

After a general survey of the main methods of calculating the atomic wave functions, a new method is described for the study of the correlations existing between the positions of electrons in atoms. 18 refs. A.

539.155.2

9838. The separation jet. A new element for gas and isotope separation. E. W. BECKER, K. BIER AND H. BURGHOFF. *Z. Naturforsch.*, **10a**, *No.* 7, 565–72 (1955) In German.

When a gas or isotope mixture flows out from a jet, a partial spatial separation of the components takes place under suitable pressure conditions. This effect may be exploited by arranging a diaphragm to separate the gas flows. The properties of such an arrangement are ascertained for different gas and isotope mixtures and discussed with regard to practical isotope separation. H. C. COLE

539.155.2

9839. Concentration of isotopes by using a very rapid electrophoresis on paper. A. BONNIN, M. CHEMLA AND P. SÜE. *C.R. Acad. Sci.* [*Paris*] **241**, *No.* 1, 40–2 (*July* 4, 1955) In French.

Describes a method of electrophoresis on paper with the use of high electric fields. When applied to

the separation of the isotopes Na^{22} and Na^{24}, the method yielded the Na^{22}/Na^{24} ratios varying from 0·28 to 1·83 from one end of the radioactive spot to the other end. F. LACHMAN

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16

9840. On the lead and sulphur isotope ratios in galena. P. EBERHARDT, J. GEISS AND F. G. HOUTERMANS. *Helv. phys. Acta*, **28**, *No.* 4, 339–41 (1955) In German.

It is suggested that the *B*- and *J*-type discrepancies which were found in determining the model age from the lead isotope ratios [Abstr. 6408 (1955)] are absent if the model age is derived from the S^{32}/S^{34} ratio. J. HUGHES

539.16.08

9841. Experiments with C^{14} using a scintillation counter. H. SCHNEIDER. *Z. angew. Phys.*, **7**, *No.* 9, 409–13 (1955) In German.

Describes techniques for estimating C^{14} in CO_2 form, using a thin-layer anthracene phosphor. The sensitivity and dark current of a number of commercial photomultiplier tubes were compared, both at room temperature and when cooled by liquid air. The circuit used includes discriminators to reduce background counts. A sample of 10 mg of CO_2 is used in measurements, and a minimum activity of $2\times10^{-4}\mu$C can be detected. E. A. ASH

539.162 : 539.153

9842. International colloquium on the role of the electron cloud in radioactive phenomena. *J. Phys. Radium*, **16**, *No.* 7, 497–640 (*July*, 1955) In French.

The colloquium was held at Paris, 28 June to 3 July, 1954. For abstracts of papers see Abstr. 9836–7, 9843, 9849, 9854, 9860–1, 9864–6, 9872–3, 9874–6, 9880–2, 9887–99.

539.162 : 539.153

9843. Effects of radioactive disintegrations on the electrons of the internal shells of the atom. J. S. LEVINGER. *J. Phys. Radium*, **16**, *No.* 7, 556–61 (*July*, 1955) ["*Electron cloud role*" *colloquium*, see Abstr. 9842] In French.

The probability of emission of atomic electrons due to β-decay is proportional to $1/Z^2$ in accord with results of many workers. The value given for the emission probability due to α-decay is smaller than that calculated by Migdal, or Schaeffer. The approximations are discussed. A.

539.163

9844. Directional correlation measurements on Ta^{181}. E. HEER, R. RÜETSCHI, F. GIMMI AND W. KÜNDIG. *Helv. phys. Acta*, **28**, *No.* 4, 336–7 (1955) In German.

This was measured for the 132 keV–480 keV cascade with scintillation counters. A liquid source of HfF_4 dissolved in HF was found to give an almost unperturbed correlation corresponding to the spin sequence 1/2-*E*2-5/2-*E*2, *M*1-7/2, with the intensity ratio of the quadrupole to dipole radiation for the 480 keV transition $\delta^2 = 43\cdot5$. From the correlation coefficients a value of 1·25 was deduced for the *g*-factor of the 480 keV level, and for spin 5/2 this gave 3·1 for the nuclear magnetic moment. J. HUGHES

539.163

9845. Production and identification of long-lived technetium isotopes at masses 97, 98 and 99. G. E. BOYD, J. R. SITES, Q. V. LARSON AND C. R. BALDOCK. Letter in *Phys. Rev.*, **99**, *No.* 3, 1030–1 (*Aug.* 1, 1955).

A Mo target was bombarded with 22 MeV protons and allowed to decay for 270 days. Mass spectrometer analysis of the chemically separated Tc showed peaks at 95, 97, 98 and 99. It is concluded that the "missing" isotope Tc^{98} like $Tc^{97,99}$ must be long lived and that no long-lived isomer of Tc^{100} exists. M. A. GRACE

539.163

9846. New elements einsteinium and fermium, atomic numbers 99 and 100. A. GHIORSO, S. G. THOMPSON, G. H. HIGGINS, G. T. SEABORG, M. H. STUDIER, P. R. FIELDS, S. M. FRIED, H. DIAMOND, J. F. MECH, G. L. PYLE, J. R. HUIZENGA, A. HIRSCH, W. M. MANNING, C. I. BROWNE, H. L. SMITH AND R. W. SPENCE. Letter in *Phys. Rev.*, **99**, *No.* 3, 1048–9 (*Aug.* 1, 1955).

Irradiation of uranium by neutrons in a thermonuclear explosion produced very heavy uranium isotopes. These decayed by β-emission to form elements of very high atomic number for which the above names (symbols E and Fm) are suggested. The detection of 99^{253} and 100^{255} (both α-emitters) is described. J. M. CASSELS

539.163

9847. Occurrence of technetium-98 in nature. E. A. ALPEROVITCH AND J. M. MILLER. *Nature* [*London*] **176**, 299–301 (*Aug.* 13, 1955).

The Tc^{98} present in selected minerals was detected by neutron activation, the Tc^{99m} formed recognized by its characteristic radiations and ½-life. The Tc^{98} concentrates have to be carefully separated from other elements likely to produce interfering γ-radiation or Tc^{99m} by alternative processes. The combination of anion-exchange chromatographic and distillation techniques developed is given. Of twelve samples examined, six gave positive results, two negative results and the rest were uncertain. J. HUGHES

539.163

9848. Neutron-deficient activities of terbium. T. H. HANDLEY AND W. S. LYON. *Phys. Rev.*, **99**, *No.* 5, 1415–17 (*Sept.* 1, 1955).

A survey was made of the neutron-deficient activities of terbium produced by proton bombardment of enriched isotopes of gadolinium. Half-lives and mass assignments are made for Tb^{156} and Tb^{154}, and the limits of half-lives for Tb^{158}, Tb^{157} and Tb^{155} are defined. Data were obtained on the γ-ray spectrum of Tb^{156}. A.

539.163.1

9849. Influence of the physical state on the half-life of Be^7. R. JACQUES. *J. Phys. Radium*, **16**, *No.* 7, 549–55 (*July*, 1955) ["*Electron cloud role*" *colloquium*, see Abstr. 9842] In French.

With a view to calculating the variation of the half-life of Be^7 as measured in the gaseous and the

solid states, the electronic wave-function of metallic Be is determined by three methods. The 3*d* method, more precise, gives a variation of about 4 per 100. The energies obtained agree with those determined by other authors and with experimental data. A.

539.163.1

9850. The half life of the 163 keV excited state in 139 lanthanum. T. R. Gerholm and H. de Waard. Letter in *Physica*, **21**, *No.* 7, 601–2 (*July*, 1955).

Delay coincidence measurements with stilbene scintillation counters on the β- and γ-rays from 84 min Ba^{139} show that the half-life of the 163 keV level in La^{139} is $15 \pm 1 \times 10^{-10}$ sec. This when corrected for internal conversion leads to a value of $27 \pm 2 \times 10^{-10}$ sec for the mean life T_γ. M. A. GRACE

539.163.1

9851. Lifetime of the 279-keV excited state of Tl^{203}. H. de Waard. Letter in *Phys. Rev.*, **99**, *No.* 3, 1045–6 (*Aug.* 1, 1955).

A half-life of $(1{\cdot}2 \pm 0{\cdot}3) \times 10^{-10}$ sec was found from β–γ delayed coincidence measurements.

J. J. WILKINS

539.163.2

9852. Half-life and radiations of the long-lived isotope of niobium (^{94}Nb). A. Rollier, E. Sæland, A. Morpurgo and A. Caglieris. *Acta chem. Scand.*, **9**, 57–67 (1955) [*JENER Publ*, *No.* 9–10 (1955)].

In order to investigate the half-life and radiation energies of Nb^{94}, spectroscopically pure metallic niobium was irradiated for 23 days with thermal neutrons in the JEEP pile. The short-lived 6·6 min Nb^{94m} β-activity was confirmed. The bulk of the slow decaying activity is due to Ta^{182} β- and γ-radiations. Many ways were tried to free efficiently the niobium metal from the tantalum impurity: anion exchange column, coprecipitation of Ta as potassium fluotantalate and Ta/Nb solvent extraction using di-*iso*propyl ketone. Only the last of these proved successful. The residual activity of the purified Nb_2O_5 is very low. From an Al-absorption curve the β-energy can be estimated to be between 0·5 and 0·6 MeV. The γ-spectrum, investigated with a scintillation spectrometer, points to three energies, namely 0·73 MeV, 0·90 MeV and 1·63 MeV. The counting rate of the β-activity, corrected for counting efficiency, indicates a half-life for the Nb^{94} of $1{\cdot}77 \times 10^4$ years ($\pm 25\%$). A.

539.163.2

9853. The RaC–RaC′ decay. S. A. E. Johansson. *Ark. Fys.*, **9**, *Paper* 35, 561–9 (1955).

The RaC–RaC′ decay has been investigated by means of a coincidence scintillation spectrometer. The γ–γ and β–γ coincidence relations have been studied in detail. Twenty γ-rays have been arranged in a consistent level scheme, which is in good agreement with the energy spectrum of the long-range α-particles from RaC′. A.

539.163.2

9854. Natural radioactivity of lutetium, rhenium and osmium. D Dixon, A. McNair and S. C. Curran. *J. Phys. Radium*, **16**, *No.* 7, 538–40 (*July*, 1955) ["*Electron cloud role*" *colloquium*, see Abstr. 9842] In French.

Studies of the decay of Lu^{176} were made using a large proportional tube spectrometer and scintillation spectrometers. Sources down to 0·1 mg/cm^2 in thickness were spread over the large cathode and the shape of the β-continuum, end-point 425 ± 25 keV, together with the internal conversion peaks observed. The conversion coefficients were evaluated. The γ-ray spectrum and the γ–γ-coincidence spectra showed that γ-rays of energies 310, 190 and 89 keV were emitted in cascade. They arose in transitions from levels of spin and parity 6^+, 4^+ and 2^+. The decay scheme fitted accurately the Bohr–Mottelson predictions. The ground state of Lu^{176} seemed to be a 10 + state. The maximum branching by *K*-capture was 3 per 100. The half-life was $4{\cdot}56 \times 10^{10}$ g for Lu^{176}. Studies by Dixon and Glover on Re^{184} and Os^{184} failed to reveal β-activity or capture and minimum half-lives of 10^{16} years were deduced. Apparent evidence of capture in Os^{184} was found to be due to a specific "background" effect and this effect could explain weak capture activities, for instance that tentatively assigned to In^{113}. Work on Na^{22} by Moljk, with extremely thin sources in the proportional tube, is important in the general problem of observing very soft Auger electrons released in capture decay. The position spectrum was found to be closely allowed in shape down to 15 keV or less. The capture intensity, as examined by searching for Auger electrons, was not more than 3 per 100. There is still some uncertainty about the release of extremely soft electrons from such sources. Experiments of Moljk and Curran on C^{14} and S^{35} as gaseous sources (CH_4 and CS_2) showed that both spectra were allowed in shape to better than 1 per 100 down to an energy of about 2 keV. New techniques for such examination were described. A.

539.163.2

9855. Decay of thallium 204. M. C. Joshi. Letter in *Curr. Sci.*, **24**, *No.* 7, 227–8 (*July*, 1955).

Weak γ-radiation of 380 ± 15 keV energy is shown by β-spectrometer measurements to accompany the decay of Tl^{204} with an intensity of $8 \pm 2 \times 10^{-5}$ per disintegration. M. A. GRACE

539.163.2

9856. Radioactivity of Gd^{159} and Tb^{161}. R. Barloutaud and R. Ballini. *C.R. Acad. Sci.* [*Paris*] **241**, *No.* 4, 389–91 (*July* 25, 1955) In French.

Decay schemes are presented, based on the results of γ–γ and β–γ coincidence measurements.

J. J. WILKINS

539.163.2

9857. Decay of ^{70}As produced by ^{14}N bombardment of Cu. A. E. Souch. Note in *Proc. Phys. Soc. A*, **68**, *Pt* 8, 760–1 (*Aug.*, 1955).

Arsenic was extracted from a Cu target which had been bombarded by N^{14} ions (10^{-7}–10^{-9} *A*, E_{max} ~125 MeV). Fifty-two min, As^{70}, identified by its half-life, showed a β^+ spectrum with components of maximum energy $1{\cdot}35 \pm 0{\cdot}03$ MeV (67%) and $2{\cdot}45 \pm 0{\cdot}04$ MeV (33%) together with a γ-ray of $1{\cdot}07 \pm 0{\cdot}04$ MeV. Evidence for γ-rays of higher energy was also found. M. A. GRACE

539.163.2

9858. Radiations from Sb^{122}. B. Farrelly, L. Koerts, N. Benczer, R. van Lieshout and C. S. Wu. *Phys. Rev.*, **99**, *No.* 5, 1440–5 (*Sept.* 1, 1955).

The radiations from Sb^{122} were investigated by use

of a magnetic solenoid spectrometer, a coincidence scintillation spectrometer, and a proportional counter spectrometer. Three β^--groups are present with end-points 1970 ± 5, 1400 ± 10 740 ± 20 keV. The highest energy β-groups exhibits an α-shape and the two lower β-groups have allowed Kurie plots; γ-ray investigations showed that four γ-rays of energies 566 ± 4, 686 ± 4, 1137 ± 6 and 1260 ± 6 keV could be associated with the decay of Sb^{122}. Coincidence techniques related the 1150 keV γ-ray with the K-capture side and also showed that the 566 and 686 keV γ-rays are in cascade. The ratio of $(K + L)$ capture relative to total β^--emission was found to be 3·1%. The ratio of K-capture to the excited state of Sn^{122} and K-capture to the ground state was found to be 1 : 2·1. The intensities of all radiations are listed and the *ft*-values for various transitions calculated. An upper limit of 10^{-3} is placed on the positron emission. A.

539.164 : 539.165

9859. A study by means of the method of α–e^- coincidences of the emission of electrons accompanying α-particles of Po^{210}. M. Duquesne. *C.R. Acad. Sci.* [*Paris*] **241,** *No.* 1, 36–7 (*July* 4, 1955) In French.

By separating the contributions due to α–X and α–e-coincidences using GM counters the intensity of electrons from autoionization and autoexcitation has been studied. M. A. GRACE

539.164 : 539.169

9860. Experimental study of internal ionization in α emission. M. Riou. *J. Phys. Radium,* **16,** *No.* 7, 583–8 (*July*, 1955) ["*Electron cloud role*" *colloquium*, see Abstr. 9842] In French.

A review of the results on α disintegration of Po^{210}, the most favourable example for the observation of internal ionization; intensities of K and L rays of lead and of the γ-ray of 800 keV emitted by Po^{210}; a deduction of the experimental probabilities of internal ionization of K and L shells; comparison with theory; results on the electrons emitted by Po^{210}. A.

539.164.2 : 539.165.2

9861. Study of the reorganization energy of the electron cloud in the phenomena of β and α radioactivity. P. Benoist-Gueutal. *J. Phys. Radium,* **16,** *No.* 7, 595–9 (*July*, 1955) ["*Electron cloud role*" *colloquium*, see Abstr. 9842] In French.

Corrections appearing in the theoretical study of β and α radioactivity when one considers the presence of the electrons of the emitting atom: (1) in the equations of conservation of energy; (2) in the calculation of the emission probability of an electron or an α-particle. A.

539.165

9862. The beta-decay of ^{233}Pa. Ong Ping Hok and P. Kramer. *Physica,* **21,** *No.* 8, 676–84 (*Aug.*, 1955).

See Abstr. 5917 (1954). Further measurements on the electron spectrum of Pa^{233} have been made. Fourteen γ-transitions were determined from the observed conversion lines. A very weak indication was found of an electron line at 360 keV which might be the K-conversion line of a 475·6 keV transition. The Fermi–Kurie analysis led to three partial β-spectra with end-points of 568 ± 5, 257 ± 5 and 145 ± 10 keV and intensities of 5%, 58% and 37% respectively. These results agree with the decay scheme proposed by Brodie. $\gamma - e^-$ and $\beta - e^-$ coincidences were also determined. A.

539.165

9863. A study by means of the method of $\beta - e^-$ coincidences of the emission of electrons accompanying β^- radiation. M. Duquesne. *C.R. Acad. Sci.* [*Paris*] **241,** *No.* 2, 195–7 (*July* 11, 1955) In French.

The intensities ($\sim 25 \times 10^{-3}$) and energy distributions of electrons accompanying β-decay in sources of P^{32}, S^{35} Pm^{147} and RaE were studied with scintillation counters. These are compared with the predictions of the theory of autoionization. M. A. GRACE

539.165

9864. Recent research on the radioactivity of A^{37}. A. Winther. *J. Phys. Radium,* **16,** *No.* 7, 562–6 (*July*, 1955) ["*Electron cloud role*" *colloquium*, see Abstr. 9842] In French.

A discussion is given on a recent experiment by Kofoed–Hansen on electron capture in A^{37}. The experimental K to L capture ratio is in strong disagreement with the theoretical. It is proposed that this may be due to the use of electron wave-functions which do not explicitly depend on the relative distance between the electrons. Also a new treatment of the final ionization of the daughter atom is proposed. A.

539.165

9865. L capture and L to K capture ratio measurement. Some experiments on Kr^{79}. Discussion of the present state of the problem. P. Radvanyi. *J. Phys. Radium,* **16,** *No.* 7, 509–15 (*July*, 1955) ["*Electron cloud role*" *colloquium*, see Abstr. 9842] In French.

L to K capture ratio of Kr^{79} was measured with a cloud chamber and with a proportional counter and found to be higher than expected theoretical value. Possible reasons for such a disagreement are discussed. Other results would not be in contradiction with hypothesis of a systematic discrepancy with theory. 37 refs. A.

539.165

9866. Proportional counter measurement of the L to K capture ratio of Kr^{79}. M. Langevin. *J. Phys. Radium,* **16,** *No.* 7, 516–19 (*July*, 1955) ["*Electron cloud role*" *colloquium*, see Abstr. 9842] In French.

L to K capture ratio of Kr^{79} was recently measured by use of a mixture of the radiative element with propane in a proportional counter. Some details are given on experimental procedure and results. A.

539.165

9867. Measurement of the ratio of L capture to K capture in argon 37. M. Langevin and P. Radvanyi. *C.R. Acad. Sci.* [*Paris*] **241,** *No.* 1, 33–5 (*July* 4, 1955) In French.

From the pulse height distribution obtained when A^{37} is introduced into a proportional counter filled with Xe a value of $0{\cdot}092 \begin{smallmatrix} +0{\cdot}010 \\ -0{\cdot}005 \end{smallmatrix}$ for this ratio is found. It is also shown that the ratio of the numbers of ion pairs produced in these two processes is 1 : 10·24. M. A. GRACE

539.165 : 539.166

9868. Beta- and gamma-ray spectroscopy. Edited by K. SIEGBAHN. *Amsterdam: North-Holland Publishing Company* (1955) xxiii + 959 *pp.* [Series in Physics].

Review in *Nature* [*London*] **176,** 414–15 (*Sept.* 3, 1955). "In addition to the techniques of nuclear spectroscopy, which are very fully and usefully covered, the theory of allowed and forbidden transitions, of multipole radiation and internal conversion, nuclear models, the technique and theory of angular correlations, the empirical classification of β-transitions and nuclear isomers, illustrative studies of particular disintegration schemes, there are also sections on such topics as double β-decay, positronium, the decay of positrons and the double Compton effect. The study of γ-radiation from charged-particle reactions and from neutron capture, both of which give information about the more highly excited states of nuclei than is usually obtainable from β-radioactivity, are also each given a chapter." A.

539.165 : 539.166

9869. Intensity rules for beta and gamma transitions to nuclear rotational states. G. ALAGA, K. ALDER, A. BOHR AND B. R. MOTTELSON. *K. Danske Vidensk. Selsk., mat.-fys. Medd.,* **29,** *Paper* 9, 22 *pp.* (1955).

Intensity rules, which arise from the relationships of the wave-functions of different states in a rotational sequence, are considered for β- and γ-transitions.

P. T. MATTHEWS

539.165 : 539.166

9870. Radioactivity of ^{134}Cs. G. BERTOLINI, M. BETTONI AND E. LAZZARINI. *Nuovo Cimento* (*Ser.* 10) **2,** *No.* 2, 273–89 (*Aug.*, 1955).

The β-decays of Cs^{134} and the γ-decays of Ba^{134} were investigated with an intermediate image β-spectrometer and a scintillation spectrometer. From β-γ coincidences a new β-decay of 335 keV endpoint was revealed and the existence of a weak β-decay on the 1 350 keV level of barium confirmed. From β-γ and γ-γ coincidences and from internal conversion coefficients, the relative intensity of the β-decays and the multipolarity of γ-transitions have been investigated. The five excited states of Ba^{134} are assumed having energies of 795, 1 350, 1 395, 1 700 and 1 949 keV. Their spins and parities are 2+, 2+, 3+ or 4+, 3+ or 4+ and 4+. A.

539.165.2

9871. On the calculation of the effect of the static Coulomb field on β-spectra. S. FLÜGGE AND W. JEKELI. Note in *Z. Naturforsch.*, **10a,** *No.* 5, 419–20 (1955) In German.

Calculations were made of the effect of screening by extra-nuclear electrons for $Z = 83$, using the Thomas–Fermi field; the correction even for $E_\beta = 2$ keV was only 7%. The influence of the finite nuclear radius on the Fermi function was also investigated; the form of the β-spectrum is scarcely affected, although for the heaviest nuclei the disintegration probability may be reduced by ~30%.

A. O. STANESBY

539.165.2

9872. Experimental study of the perturbation caused in the electron cloud by β disintegration and electron capture. G. CHARPAK. *J. Phys. Radium,* **16,** *No.* 7, 567–72 (*July*, 1955) ["*Electron cloud role*" *colloquium*, see Abstr. 9842] In French.

Analysis of experimental methods in the study of autoionization effects in β-decay and K capture. Experiments on Fe^{55} and P^{32} show agreement with theory but for a still unexplained tail of electrons above 5 keV, in coincidence with P^{32} β-rays in five cases in a 1 000, and whose half-thickness value is 0·2 mg/cm^2 Al. A.

539.165.8

9873. Demonstration of re-arrangement radiation following the autoionization consequent upon β disintegration. G.-A. RENARD. *J. Phys. Radium,* **16,** *No.* 7, 575–7 (*July*, 1955) ["*Electron cloud role*" *colloquium*, see Abstr. 9842] In French.

Measurements, by proportional counting, of the K X-rays of P^{32}, K and L of Sr^{90}–Y^{90}, in equilibrium, L and M of RaE, following autoionization; most of the values obtained are compatible with theoretical values. A.

539.166

9874. Mixture of M_1 and E_2 transitions. N. MARTY AND H. LANGEVIN. *J. Phys. Radium,* **16,** *No.* 7, 531–3 (*July*, 1955) ["*Electron cloud role*" *colloquium*, see Abstr. 9842] In French.

The possible relation of the experimental evidence of mixed M_1–E_2 γ transitions, not explained theoretically by the one-particle model, to the existence of rotational levels is studied. Two tables are given of the mixed M_1–E_2 radiations for odd A and even-even nuclei, with, in the first case, the Coulombian excitation levels when they are known. A.

539.166

9875. The fluorescence yield. E. H. S. BURHOP. *J. Phys. Radium,* **16,** *No.* 7. 625–9 (*July*, 1955) ["*Electron cloud role*" *colloquium*, see Abstr. 9842] In French.

It is shown that when allowance is made for screening and relativistic effects the variation with Z of the fluorescence yield ω, is expected to be of the form $[\omega/(1-\omega)]^{\frac{1}{4}} = A + BZ + CZ^3$, where the constant A includes the effect of screening and C that of relativity. Values of A, B and C are determined from a least-squares fit of the K-series fluorescence yield experimental data, and values in good agreement with theoretical expectations are obtained. Values of A and B (assuming $C = 0$) are also obtained from a least square fit of the rather meagre L series data. The best values for L and M series yield are also discussed. A.

539.166

9876. Spectrography of the fluorescent radiations of the radioelements. M. FRILLEY. *J. Phys. Radium,* **16,** *No.* 7, 630–4 (*July*, 1955) ["*Electron cloud role*" *colloquium*, see Abstr. 9842] In French.

The ionization of electronic shells resulting from certain radioactive transmutations is followed by the emission of fluorescent photons. The K and L spectra are considered, then their energy and intensity and the information which can be obtained on the transitions generating them. A.

539.166

9877. Angular correlation of gamma rays from Fe^{*56}. M. Sakai. *J. Phys. Soc. Japan*, **10**, *No.* 9, 729–34 (*Sept.*, 1955).

The γ-rays emitted in the decay of Co^{56} were studied by γ-γ angular correlation measurements. The results of these experiments permitted the discussion of the energy levels of the daughter nucleus, Fe^{56}. The γ-γ coincidence experiment showed the presence of 2·03 MeV γ-ray decaying to the second excited level. One part of the decay scheme was confirmed by positron-γ coincidence experiment. The first and the second excited levels were assigned to be 2+ and 4+ respectively from the special consideration on the angular correlation data. The spins of the other levels were discussed also. A.

539.166

9878. Gamma-gamma directional correlation in Pt^{192}. H. W. Taylor and R. W. Pringle. *Phys. Rev.*, **99**, *No.* 5, 1345–6 (*Sept.* 1, 1955).

Spins have been tentatively assigned to the first five states of Pt^{192}, the proposed spin sequence being 0, 2, 2, 3 (4), 4. The 296 and 468 keV transitions appear to be dipole-quadrupole mixtures. For the former, the percentage quadrupole radiation is 97·5% and for the latter, 5·8%. A.

539.166

9879. A precision re-measurement of the ^{60}Ni gamma-gamma directional correlation function. S. Colombo, A. Rossi and A. Scotti. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 3, 471–86 (*Sept.*, 1955).

A precision remeasurement of the directional correlation function of the Ni^{60} γ-γ cascade, obtained through β-decay of metallic Co^{60}, has been made. The experimental apparatus includes as scintillation counters Type 6292 photomultipliers, coupled with 1 in. × 1 in. cylindrical anthracene crystals, and a coincidence circuit with a resolving time of 4×10^{-8} sec. The experimental results are reported, with a discussion of the systematic errors involved and of the experimental corrections introduced. The comparison with the theoretical results, assuming the usual unperturbed 4($E2$)2($E2$)0 cascade, shows a very close agreement. A.

539.166 : 539.152.2

9880. The angular distribution of the radiations emitted by oriented nuclei: the influence of the precession of nuclear spins in intermediate states, particularly after a K capture. H. A. Tolhoek, C. D. Hartogh and S. R. de Groot. *J. Phys. Radium*, **16**, *No.* 7, 615–21 (*July*, 1955) ["*Electron cloud role*" *colloquium*, see Abstr. 9842] In French.

Oriented nuclei may emit γ-radiation with anisotropic angular distribution, which is mostly preceded by a β-emission or K-capture. The influence of the precession of the nuclear spin in the intermediate state is studied. After K-capture a strong coupling between the nuclear spin and the remaining K-electron exists, but its influence on the angular distribution is small, due to the short lifetime of the atomic intermediate state. A.

539.166 : 539.167

9881. Some aspects of the influence of the electron cloud on the emission of nuclear radiations. M. A. Grace. *J. Phys. Radium*, **16**, *No.* 7, 622–4 (*July*, 1955) ["*Electron cloud role*" *colloquium*, see Abstr. 9842] In French.

It is shown that in the angular correlation of the γ-rays in Ni^{60} no influence arises through electronic relaxation phenomena: this result is considered in relation to nuclear orientation experiments. The isotropic distribution of γ-radiation from oriented Co^{57} nuclei is discussed. A.

539.166 : 539.167

9882. The influence of the peripheral electrons of the atom on the angular correlation of successive nuclear radiations. E. Heer. *J. Phys. Radium*, **16**, *No.* 7, 605–8 (*July*, 1955) ["*Electron cloud role*" *colloquium*, see Abstr. 9842] In French.

The influence of the magnetic dipole moment and the electric quadrupole moment of the electron shell on the angular correlation of successive nuclear radiations is discussed. As an example the experiments on the Cd^{111} γ-γ cascade are examined. It is shown that most of the observed effects can be explained by the electric quadrupole interaction with surrounding electric fields. In some cases magnetic dipole interaction with the excited electron shell may also be of importance. Methods are described to measure nuclear moments of excited states on one hand and to measure the undisturbed angular correlaon the other hand. A.

539.166.08 : 537.542

9883. Gamma-ray scintillation spectrometer with logarithmic pulse-height response. D. Maeder. *Rev. sci. Instrum.*, **26**, *No.* 9, 805–8 (*Sept.*, 1955).

Practical use of scintillation spectrometers is unnecessarily complicated by the strong predominance of small pulses encountered especially in measuring complex spectra. The difficulties arising from this general trend can be reduced by deforming the pulse spectra before recording them in a conventional linear pulse-height analyser. A discussion of energy dispersion obtained with different types of deformation shows that a logarithmic transformation not only multiplies the counting rates of the original spectrum with a factor proportional to energy, but at the same time increases the energy band which can be resolved with a given number of counting channels. The reduction of counting rate extremes obtained by such a transformation permits attainment of higher total counting speeds with given multichannel equipment (assuming equal scaling factors in all channels); on the other hand, it facilitates accurate intensity measurements using photographic recording techniques. An electronic circuit is described, which accepts input pulses having a sharp rise ($<1\mu$sec) and produces, 30 μsec later, a d.c. voltage in linear relationship with log [input pulse height]. The 100 V range of the output voltage is adjustable to cover pulse-height ratios from 1 : 2 up to 1 : 50. Grey-wedge spectrograms of the γ-rays from Ra taken with the usual linear and with the new logarithmic circuit are presented. Theoretical calculations, as well as measurements with various calibration sources show that the photopeak counting efficiency of a NaI spectrometer becomes nearly constant over a wide energy range when the logarithmic energy transformation is introduced. A.

539.166.08 : 578

9884. An apparatus for the measurement of γ-radiation from the human body. J. RUNDO. *J. sci. Instrum.*, **32**, *No.* 10, 379–84 (*Oct.*, 1955).

The design and construction of a total-body γ-monitor is described. It employs four long, high-pressure ionization chambers connected differentially with four similar chambers to reduce the background intensity. The chambers are mounted in a water-filled steel tank, to provide shielding against local γ-radiation. The differential current develops a potential across a stable high-value resistor, and this potential is amplified by a vibrating reed electrometer. The amplified output is displayed on an electromechanical recorder and the mean out-of-balance current is determined automatically. The errors are such that a two-hour measurement of body radioactivity enables the potassium content of a subject to be determined with a probable error of about 17% under ideal conditions. A.

539.166.75

9885. Tenth-value thicknesses for gamma-ray absorption. J. MOTEFF. *Nucleonics*, **13**, *No.* 7, 24 (*July*, 1955).

Thicknesses of H_2O, C, Al, normal and barytes concretes, Fe, Pb, W and U, required to produce a tenfold attenuation of a narrow beam of γ-rays, are plotted for the energy range 0·1–10 MeV. The energy at which narrow beam attenuation is a minimum is plotted against Z and the γ-ray fluxes corresponding to 1 r/hr are plotted against energy. L. R. SHEPHERD

539.166.8

9886. On the energy distribution and the emission probability of internal bremsstrahlung in $^{71}_{32}$Ge. A. BISI, E. GERMAGNOLI, L. ZAPPA AND E. ZIMMER. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 2, 290–300 (*Aug.*, 1955).

The continuous γ-spectrum due to bremsstrahlung associated with the orbital electron capture in Ge^{71} has been investigated with a scintillation spectrometer. The intensity distribution of the spectrum in the energy range between 50 keV and the upper limit of energy ($E_{max} = 220 \pm 3$ keV) was found to agree closely with the one calculated according to the theory developed by Morrison and Schiff. The ratio of the total number of bremsstrahlung quanta to the number of K-captures in the interval of energy between 70 keV and the upper limit was $(2{\cdot}3 \pm 0{\cdot}5) \times 10^{-5}$, which also is in satisfactory agreement with the theoretical value. The half-life of Ge^{71} was checked and found to be $12{\cdot}5 \pm 0{\cdot}1$ days. The type of transition is briefly discussed according to nuclear shell model. Some results concerning the decay of As^{77} are also reported. A.

539.166.83

9887. On the natural width of conversion electron lines. M. VALADARES. *J. Phys. Radium*, **16**, *No.* 7, 542–4 (*July*, 1955) ["*Electron cloud role*" *colloquium*, see Abstr. 9842] In French.

The relation which exists between the width of conversion lines and the width of X-ray absorption discontinuities is discussed. The knowledge of the natural width of conversion lines could contribute to the solution of a certain number of problems that are indicated. A.

539.166.83

9888. Conversion coefficients of the L shell. I. M. E. ROSE. *J. Phys. Radium*, **16**, *No.* 7, 520–3 (*July*, 1955) ["*Electron cloud role*" *colloquium*, see Abstr. 9842] In French.

A discussion of the role of internal conversion in nuclear spectroscopy and a brief description of the underlying assumptions and the method of calculation of conversion coefficients is given. Preliminary conclusions based on results so far obtained are presented. A.

539.166.83

9889. Internal conversion: comparison of some experimental and theoretical results. J. TEILLAC. *J. Phys. Radium*, **16**, *No.* 7, 524–30 (*July*, 1955) ["*Electron cloud role*" *colloquium*, see Abstr. 9842] In French.

The coefficients of internal conversion can be calculated as a function of the energy of transition, of the nature and polarity of γ-radiation and of the characteristics of the ejected electron. On the other hand, the coefficients of conversion or their relative value in different levels can be measured experimentally. The comparison of the experimental results with those of calculations recently developed allows the solution of a certain number of problems concerning the transitions between nuclear levels and the interaction between nucleus and electrons. A.

539.166.83

9890. Coefficients of internal conversion in the case of isomeric transitions of some stable nuclei. I. ANTONOVA AND U. ESTULIN. *J. Phys. Radium*, **16**, *No.* 7, 534–7 (*July*, 1955) ["*Electron cloud role*" *colloquium*, see Abstr. 9842] In French.

Determination of internal conversion coefficients for isomeric transitions of Sr^{87*}, In^{113*}, In^{115*}, using absolute intensity countings measured with two ionization chambers, one thimble-shaped for the β, the other slit-shaped for the γ. Results are in agreement with other experimental measurements, but disagree with theoretical values. A.

539.166.83

9891. The role of internal conversion in the study of isomeric transitions. M. GOLDHABER. *J. Phys. Radium*, **16**, *No.* 7, 541 (*July*, 1955) ["*Electron cloud role*" *colloquium*, see Abstr. 9842] In French.

The rate with which internal conversion takes place in competition with γ-ray emission can be calculated with great accuracy for a given electron distribution and given multipolarity and energy of the γ-ray. An experimental determination of the internal conversion coefficient, and sometimes only of the K/L or $L_I : L_{II} : L_{III}$: ratio, forms therefore a very useful "tool" for the study of nuclear γ-ray transitions. A.

539.166.83

9892. The widths of conversion lines. M. MLADJENOVIĆ. *J. Phys. Radium*, **16**, *No.* 7, 545–8 (*July*, 1955) ["*Electron cloud role*" *colloquium*, see Abstr. 9842] In French.

Measurements of the width of the principle lines of the internal conversion spectrum of RaB. Examination of the factors which could give the conversion lines widths different from those obtained by X-ray analyses. A.

539.166.83

9893. Internal bremsstrahlung accompanying electron capture. R. J. GLAUBER AND P. C. MARTIN. *J. Phys. Radium*, **16**, *No.* 7, 573–4 (*July*, 1955) ["*Electron cloud role*" *colloquium*, see Abstr. 9842] In French.

The shape of the continuous γ-ray spectrum accompanying orbital electron capture has been computed taking Coulomb effects into account. Up to several times the characteristic X-ray energy, radiative capture of p-electrons is more probable than that of s-electrons. The large quantity of low-frequency radiation is in agreement with experiment. A.

539.166.83

9894. On the angular correlations of conversion electrons, with a special study of the Cd^{111} cascade. E. HEER. *J. Phys. Radium*, **16**, *No.* 7, 600–4 (*July*, 1955) ["*Electron cloud role*" *colloquium*, see Abstr. 9842] In French.

The γ-γ angular correlation is an important tool in modern nuclear spectroscopy. It gives us the possibility of determining angular momenta of nuclear levels and multipole orders of γ-transitions. In principle, the same information can be obtained if the conversion electrons are measured instead of the γ-rays. This procedure is especially well suited for reasons of intensity in cases of high conversion coefficients. The principal difficulty which then occurs is the problem of the source. This source must be sufficiently thin to avoid scattering of the electrons and at the same time must show no influence of external fields on the angular correlation. Experiments with the cascade of Cd^{111} are described, where sources consisting of a thin liquid metallic film were used successfully. A.

539.166.83

9895. A study of the L-level Auger electrons emitted in the disintegration of Au^{199}. S. K. HAYNES AND W. T. ACHOR. *J. Phys. Radium*, **16**, *No.* 7, 635–7 (*July*, 1955) ["*Electron cloud role*" *colloquium*, see Abstr. 9842] In French.

The L Auger yield of Au^{199} has been studied in a β-ray spectrometer. The ratio of L Auger electrons to L vacancies was $0{\cdot}629 \pm 0{\cdot}035$. Insufficient resolution and uncertain $L_I \rightarrow L_{III}$ Coster–Kronig yield prevented determination of precise L subshell Auger yields. Approximate values of $0{\cdot}577 \pm 0{\cdot}09$ and $0{\cdot}658 \pm 0{\cdot}01$ were obtained for the L_{II} and L_{III} shells respectively. A.

539.166.83

9896. The Auger electrons of ThB. M. MLADJENOVIĆ AND H. SLÄTIS. *J. Phys. Radium*, **16**, *No.* 7, 638–9 (*July*, 1955) ["*Electron cloud role*" *colloquium*, see Abstr. 9842] In French.

Recent results on the energy and intensity of the K Auger lines of ThB. Comparison with theory. A.

539.166.83 : 539.169

9897. Internal bremsstrahlung and atomic ionization accompanying the β emission of Y^{90} and RaE. A. MICHALOWICZ AND R. BOUCHEZ. *J. Phys. Radium*, **16**, *No.* 7, 578–82 (*July*, 1955) ["*Electron cloud role*" *colloquium*, see Abstr. 9842] In French.

With the aid of a Na I(Tl) scintillation spectrometer the internal bremsstrahlung and the atomic ionization for the forbidden transitions Y^{90} and RaE have been studied. The results on the bremsstrahlung are in accord with the simplified theory of Knipp and Uhlenbeck; those on the K ionization agree with the formula of Levinger $0{\cdot}92/Z^2$, while that of Migdal, $0{\cdot}64/Z^2$, gives too small a value. A.

539.166.835

9898. The analysis of the phenomenon of the production of monoenergetic positrons. L. A. SLIV. *J. Phys. Radium*, **16**, *No.* 7, 589–93 (*July*, 1955) ["*Electron cloud role*" *colloquium*, see Abstr. 9842] In French.

Formulae for the coefficients of conversion with the formation of positrons with single energy have been obtained for different kinds of radiations and their analysis has been carried out. The question has been examined of the possibility of using the formation of positrons with single energy to determine the width of nuclear levels with energies of excitation of 1–6 MeV. A.

539.166.835

9899. On the monopole transition pairs of O^{16}. S. GORODETZKY, R. ARMBRUSTER AND P. CHEVALLIER. *J. Phys. Radium*, **16**, *No.* 7, 594 (*July*, 1955) ["*Electron cloud role*" *colloquium*, see Abstr. 9842] In French.

The angular correlation of the monopole transition electron pairs from the first excited level o^+ of O^{16} is studied experimentally. The luminosity of the apparatus employed allows—by an absorption method—the study of this angular correlation in different energy regions of the electrons. A.

539.167

9900. Extranuclear effects on angular correlations of nuclear radiations. R. M. STEFFEN. *Advances in Phys.*, **4**, *No.* 15, 293–362 (*July*, 1955).

A theoretical and experimental study of the influence on the angular correlation of nuclear radiations of different chemical and physical states of the radioactive source. 104 refs. A. O. STANESBY

539.167.3

9901. The isolation of americium 241. J. MILSTED. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. C/R*1102, 7 *pp.* (1955).

Americium has been isolated by conventional chemical methods without the addition of any rare-earth carriers. The source of the material was the β-decay of Pu^{241} in plutonium extracted from pile-irradiated uranium. The identity of the product was confirmed by α energy, emission and absorption spectra, and γ-ray measurements. There is evidence that rare-earth impurities were very small. A.

539.167.3

9902. Production of radioactive organic compounds with recoil tritons. R. WOLFGANG, F. S. ROWLAND AND C. N. TURTON. *Science*, **121**, 715–17 (*May* 20, 1955).

It is possible to label organic material with T, using the reaction $Li^6(n, \alpha)T$. Equal amounts of dry Li_2CO_3 and glucose were ground and mixed in a mortar, before a 65-hours exposure to a flux of 6×10^9 neutrons/cm^2 sec. Sample thickness was $0{\cdot}8$ g/cm^2. After purification by converting the glucose into the pentaacetate and repeated recrystallization, the glucose showed a specific activity of $3\,\mu$c/g. In a similar experiment, carried out by L. Kaplan, Li_2SO_4 and benzoic acid were used and a specific activity of $96\,\mu$c/g in the benzoic acid was achieved. Possible applications of this method are discussed. M. EBERT

539.169

9903. The recovery of tritium used in ion accelerators. D. L. Allan, J. Carey, J. F. McCahon and M. J. Poole. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. N/R*494, 3 *pp.* (1955).

A method of recovering tritium gas used in the ion source of a particle accelerator is described. A.

NUCLEAR REACTIONS 539.17

539.17 : 518.5

9904. An analogue computer for nuclear reactions. E. S. Shire. *J. sci. Instrum.*, **32**, *No.* 10, 391–2 (*Oct.*, 1955).

Given the energy of the incident particle and the *Q*-value of the reaction, the energy of the emitted particle can be read directly from the computer for any angle in laboratory or centre-of-mass space. The ratio of the number of particles emitted per unit solid angle in centre-of-mass space to the corresponding number measured in laboratory space can also be read directly. A.

539.17 : 519.2

9905. On a possible application of the correlation function to the study of nuclear transformations. V. I. Gol'danskiĭ and M. I. Podgoretskiĭ. *Dokl. Akad. Nauk SSSR*, **100**, *No.* 2, 237–40 (1955) In Russian.

The usual method of studying the characteristics of a transformation by registering in a time T the numbers of two types of events l and k and the number of coincidences, is a partial example of a statistical method in which T is divided into n intervals and the numbers of events, r_e and r_k, and their product $r_e r_k$ are averaged over n. Expressions for the average value and standard deviation of the correlation function $\Phi_{lk} = \overline{r_e r_k} - \overline{r_e}\,\overline{r_k}$ are given in the case when l and k are either independent or correlated, also in the presence of background. In addition to all problems studied by the coincidence method, the correlation method can be used, e.g. for the determination of (*a*) reaction cross-sections [e.g. for $Be^9(n\alpha)He^6 \xrightarrow{\beta} Li^6$ by the study of $\overline{r_\alpha}$ and $\overline{r_\beta}$], (*b*) the identification of reaction products, (*c*) half-life determinations without separation of the sample from the equilibrium mixture. W. J. Swiatecki

539.172

Nuclear reactions due to cosmic rays. *See also under* "Cosmic rays." Decimal classification 537.591.8

539.172.1

9906. Inelastic scattering by rotational excitation. S. Hayakawa and S. Yoshida. *Proc. Phys. Soc. A*, **68**, 656–8 (*July*, 1955).

The influence of rotational excitation on the inelastic scattering of nucleons by heavy nuclei, using a partial wave-analysis. P. T. Matthews

539.172.11/.13

9907. Elastic scattering of protons, deuterons, and alpha particles from heavy elements. H. E. Gove. *Phys. Rev.*, **99**, *No.* 5, 1353–5 (*Sept.* 1, 1955).

The elastic scattering of 7·8 MeV protons from Au^{197}, 27·5 MeV α-particles from Au^{197} and 15·2 MeV deuterons from Pb^{208} and Bi^{209} has been measured as a function of angle. Except for the proton scattering which bears a constant ratio to Coulomb scattering, the cross-sections when plotted as a ratio to the Coulomb cross-sections fall sharply below unity at an angle of about 50° for the α-particles on gold and about 30° for the deuterons on lead and bismuth. The absolute cross-section for elastic scattering of 15·2 MeV deuterons from gold at 30° is equal to the Coulomb value within 20%, the energy variation is proportional to E^{-2} from 15·2 to 8·5 MeV to within 6%, also at 30°. A.

539.172.11/.13

9908. Elastic scattering of alpha particles and deuterons by complex nuclei. C. E. Porter. *Phys. Rev.*, **99**, *No.* 5, 1400–5 (*Sept.* 1, 1955).

The elastic scattering of α-particles and deuterons by heavy nuclei is calculated approximately using a classical approach. Rough agreement with the available α-particle data is obtained with a ratio of interaction radius to mean free path near the centre of the nucleus of about 3 to 4 and a $(1/e)$ edge-diffuseness distance of 1×10^{-13} cm. Interpretation of the available deuteron data is somewhat uncertain at present. A.

539.172.13 : 539.166

9909. Proton capture gamma rays from the reaction $P^{31}(p,\gamma)S^{32}$ leading to the ground and first excited states of S^{32}. E. B. Paul, H. E. Gove, A. E. Litherland and G. A. Bartholomew. *Phys. Rev.*, **99**, *No.* 5, 1339–44 (*Sept.* 1, 1955).

Resonances in the reaction $P^{31}(p,\gamma)S^{32}$ which show transitions to the ground or first excited state of S^{32} have been studied for proton energies between 0·68 and 2·35 MeV. Angular distributions have been measured at resonances at 0·816, 0·825, 1·117, 1·146, 1·248, 1·892, 1·985, 2·027, 2·120, 2·320 and 2·340 MeV. These distributions along with the $P^{31}(p,\alpha_0)Si^{28}$ results enabled assignments of $1-$ to be made for the resonances at 1·892, 2·027 and 2·120 MeV, of $1\pm$ for those at 0·825, 1·117, 1·985, 2·320 and 2·340 MeV, and of $2\pm$ to that at 1·248 MeV. Partial widths for γ_0 and γ_1 were also measured and are compared with theory. Analysis of the angular distributions at one resonance suggests that the spin of the first excited state of S^{32} at 2·25 MeV is $2+$. The reduced proton widths for the three resonances with $J = 1-$ together amount to 60% of the single-particle width. A.

539.172.13

9910. Disintegration of the Be^9-nucleus in Coulomb field. J. Sawicki. *Acta phys. Polon.*, **14**, *No.* 1–2, 135–41 (1955).

The cross-section for the disintegration ($Be^9 \rightarrow Be^8 + n$) of high-velocity Be^9 nuclei by heavy nuclei ($Z \gg 1$) and the disintegration of Be^9 nuclei by high-velocity protons is calculated by Dancoff's method. Attention is centred on those processes in which there is no direct nuclear collision and where the disintegration is due to electric forces. The cross-section σ for 170 MeV Be^9 nuclei is of the order $4\cdot2\times10^{-29}Z^2\,cm^2$ and $3\cdot5\times10^{-29}Z^2\,cm^2$ for 265 MeV Be^9 nuclei. For 18·8 MeV protons $\sigma \simeq 4\cdot75\,.\,10^{-29}\,cm^2$ and for 29·14 MeV protons $\sigma \simeq 4\cdot1\times10^{-29}\,cm^2$. Quantitatively this process seems usually to be less important

than the disintegration involving a direct nuclear collision. A.

539.172.13

9911. Angular distribution of deuterons from $Be^9(p, d)Be^8$. I. J. Dąbrowski and J. Sawicki. *Acta phys. Polon.*, **14**, *No.* 1–2, 143–7 (1955).

The pickup process $Be^9(p, d)Be^8$ is investigated The differential cross-section is calculated with use of Born's approximation. Contrary to the simplifying assumptions used by Bhatia *et al.* the exact wave-functions of beryllium are used in the calculations under the assumption of the nuclear shell model of the Be^9 nucleus. A formula available for numerical calculations is obtained. A.

539.172.13

9912. Mechanism of the reaction $C^{12} + p \rightarrow p + 3\alpha$ at 29 MeV. J. L. Need. *Phys. Rev.*, **99**, *No.* 5, 1356–66 (*Sept.* 1, 1955).

A methane-filled expansion cloud chamber, operated at $\frac{1}{3}$ atmosphere, was used to study the $C^{12} + p \rightarrow p + 3\alpha$ reaction. Two hundred events that satisfied momentum and energy conservation were accepted for analysis. One hundred and forty-eight of these had all four prongs visible; the remaining fifty-two had only three visible prongs with the fourth prong directed into an invisible region of the chamber. One-quarter of the events proceeded via the Be^8 ground state and at least one half via the 2·9 MeV level in Be^{8*}; possibly higher levels in Be^8 were also involved. Evidence for the participation of levels in C^{12} at 9·6, 16, 20 and 25 MeV was found. There is evidence that the $C^{12}(p, \alpha)B^9$ reaction also participates, with levels at 0 and $3{\cdot}2 \pm 1{\cdot}0$ MeV. The possibility of the $C^{12} + p \rightarrow Li^5 + Be^8$ reaction was investigated and it was concluded that it could account for at most 5% of the events. At least one example of the $C^{13}(p, d)3\alpha$ reaction was seen. A.

539.172.13

9913. $T(p, \gamma)He^4$ reaction. J. E. Perry, Jr and S. J. Bame, Jr. *Phys. Rev.*, **99**, *No.* 5, 1368–75 (*Sept.* 1, 1955).

The $T(p, \gamma)He^4$ reaction has been studied over the proton energy range 0·1 to 6·2 MeV, by detecting the γ-rays with a sodium iodide scintillation counter. The 90° excitation function rises to a maximum in the region of 4 to 5 MeV and drops off slightly at higher energies. The angular distribution, measured at four energies, shows that in addition to the $\sin^2\theta$ distribution previously reported there is a small asymmetry about 90° of the form $\sin^2\theta\cos\theta$, which increases with proton bombarding energy. This asymmetry has been studied over the entire energy range. Absolute yield measurements of the reaction give a 90° differential cross-section at 1 MeV at $3{\cdot}65 \times 10^{-30}$ cm^2 per steradian, which is considerably lower than has been previously reported. A.

539.172.13

9914. Proton-neutron threshold measurements. J. D. Kington, J. K. Bair, H. O. Cohn and H. B. Willard. *Phys. Rev.*, **99**, *No.* 5, 1393–6 (*Sept.* 1, 1955).

New values for the (p, n) thresholds of N^{15}, Mg^{25}, Mg^{26}, Cu^{63} and Cu^{65} are, in corresponding order, $3\,776 \pm 8$, $5\,289 \pm 25$, $5\,200 \pm 10$, $4\,213 \pm 8$ and $2\,170 \pm 5$ keV. The value given for Mg^{26} is for the transition to the first excited state in Al^{26}. In the process of providing an energy calibration curve for the magnetic analyser of the Oak Ridge National Laboratory 5·5 MV Van de Graaff, it was found that the resonances in the $F^{19}(p\,\alpha\gamma)O^{16}$ reaction reported by others at 1 355 and 1 381 keV actually occurred at proton energies of $1\,347 \pm 2$ and $1\,374 \pm 2$ keV, respectively. Previous measurements on the (p, n) thresholds of F^{19}, Na^{23} and Al^{27}, which were based in part on these resonances as calibration points, have been repeated, giving $4\,240 \pm 8$, $5\,053 \pm 10$ and $5\,792 \pm 10$ keV, respectively. A.

539.172.13

9915. Elastic scattering of protons by He^3 and T. R. M. Frank and J. L. Gammel. *Phys. Rev.*, **99**, *No.* 5, 1406–10 (*Sept.* 1, 1955).

A phase-shift analysis is made of the p-He^3 and p-T elastic scattering data using theoretical predictions wherever possible to reduce the number of parameters. It is pleasing that the resulting phase shifts all have their expected signs and reasonable magnitudes and satisfy relations connecting the p-T and p-He^3 phase shifts. The analysis was also made without using the theoretical conditions, and all the solutions found are presented. However, these other solutions are rejected. The phase shifts accepted as correct are discussed in terms of resonances. A.

539.172.13

9916. High-energy fission of heavy elements. Nuclear charge dependence. P. Kruger and N. Sugarman. *Phys. Rev.*, **99**, *No.* 5, 1459–69 (*Sept.* 1, 1955).

Radiochemical studies of the fission of heavy elements ($_{67}Ho^{165}$ to $_{90}Th^{232}$) with 450 MeV protons have been performed. Radioactive nuclides varying in mass number from 59 to 115 were isolated from the various targets and, from their measured cross-sections, the cross-section *v.* mass number dependence was determined on the assumption of a yield *v.* charge distribution curve constant with mass number of the fission product and atomic number of the target nucleus. The integrated fission cross-sections, in barns, were calculated to be 0·67, 0·21, 0·061, 0·019, 0·0050 and ~0·002 for thorium, bismuth, gold, rhenium, tantalum and holmium, respectively. Anomalies in the cross-sections and most probable charge values for the heavier nuclides isolated from holmium suggest the existence of another competing process, labelled "fragmentation," along with spallation and fission. The importance of this process in heavy element bombardment is discussed. A.

539.172.13

9917. High-energy fission of bismuth. Proton energy dependence. L. G. Jodra and N. Sugarman. *Phys. Rev.*, **99**, *No.* 5, 1470–4 (*Sept.* 1, 1955).

Radiochemical studies of the fission of bismuth with protons of 75 MeV to 450 MeV have been performed. Radioactive products ranging from Cu^{61} to Cs^{131} were isolated and their cross-sections were measured. Integration of the calculated cross-section *v.* mass number curves for the various energies yielded values for the fission cross-section which increase rapidly from a value of 0·016b at 75 MeV to 0·12b at 192 MeV, then more slowly to 0·20b at 450 MeV. The most probable fission products decrease in mass

and in neutron to proton ratio as the proton energy increases. A.

539.172.13

9918. Mirror reactions $H^3(d,n)He^4$ and $He^3(d,p)He^4$. D. P. HALE AND R. D. PRESENT. *Phys. Rev.*, **99**, *No.* 5, 1366–7 (*Sept.* 1, 1955).

Experimental data for these two reactions in the low-energy region from 64 to 954 keV (centre-of-mass) have been analysed assuming only (1) a well-defined nuclear surface, (2) charge symmetry and (3) a single entrance channel. The one-level resonance formula was not used in this work. The results indicate consistency over the entire energy range between experiment, the hypothesis of charge symmetry and basic assumptions of reaction theory. A.

539.172.13

9919. Angular distributions for $Ti^{46,48}(d,p)Ti^{47,49}$ reactions with 4·16-MeV deuterons. L. L. LEE, JR AND W. RALL. *Phys. Rev.*, **99**, *No.* 5, 1384–6 (*Sept.* 1, 1955).

Angular distributions of protons resulting from reactions of Ti^{46} and Ti^{48} with 4·16 MeV deuterons have been measured in the forward direction for several levels of the residual nuclei. For protons from the 1·35 and 1·70 MeV states of Ti^{49} the distributions show a peak at an angle about 5° larger than that expected from simple deuteron-stripping theory. The reaction to the ground state of Ti^{47} appears to proceed largely through the compound nucleus at this deuteron energy. The measured angular distribution of protons from the 1·40 MeV excited state indicates an assignment of $L = 1$ for the captured neutron, hence odd parity and spin $\frac{1}{2}$ or $\frac{3}{2}$ to the level in Ti^{47}. A.

539.172.13

9920. Deuteron stripping processes at high energies. R. J. GLAUBER. *Phys. Rev.*, **99**, *No.* 5, 1515–16 (*Sept.* 1, 1955).

The processes which lead to the formation of stripped particle beams in encounters of high-energy deuterons with heavy nuclei are discussed. It is shown that a significant role is played by a previously unnoticed dissociation process arising from diffractive effects in which, from a classical standpoint, the particles suffer no collisions. A.

539.172.3

9921. Lectures on photoproduction. G. BERNARDINI. *Nuovo Cimento Suppl.* (*Ser.* 10) **2**, *No.* 1, 104–38 (1955).

Review article. Approximate theoretical formulae, obtained largely from Fermi's lectures [Abstr. 9424 (1955)] are compared with experiments. Extensive experimental information on cross-sections and angular distributions is summarized. Features of the angular distributions of mesons produced by different γ-ray multipoles are derived. G. E. BROWN

539.172.3

9922. Photomeson production from hydrogen. B. T. FELD. *Nuovo Cimento Suppl.* (*Ser.* 10) **2**, *No.* 1, 139–44 (1955).

Angular distributions between threshold and 450 MeV can be fitted by formulae with reasonable parameters; mesons of angular momentum $l \leqslant 1$ are used. G. E. BROWN

539.172.3

9923. The photodisintegration of the deuteron at high energies and associated phenomena. B. T. FELD. *Nuovo Cimento Suppl.* (*Ser.* 10) **2**, *No.* 1, 145–50 (1955).

A short survey. Low-energy results are reasonably explained by static theories, but the constancy and large value of $\sigma_{tot.}$ above $E_\gamma \sim 100$ MeV and the decrease in the $\sin^2\theta$ term in the angular distribution cannot be explained by present theories. It appears that photodisintegration of the deuteron is the process primarily responsible for the photoproduction of high-energy neutrons and protons in heavier nuclei.

G. E. BROWN

539.172.3

9924. The nuclear photo-effect in nickel, copper and zinc. Z. DLOUHÝ, V. PETRŽÍLKA AND M. ROZKOŠ. *Czech. J. Phys.*, **5**, *No.* 2, 193–200 (*April*, 1955) In Russian, with summary in English ($\frac{1}{2}$ *p.*).

Collimated γ-rays from the reaction $Li^7(p,\gamma)$ irradiated a thin foil of the element in question placed between photographic plates which detected the protons. The γ-ray beam intensity was measured by a G.M. counter calibrated by the reaction $Cu^{63}(\gamma,n)$ for which the cross-section is known. The measured total cross-sections were $8 \pm 4\times10^{-26}$, $7 \pm 4\times10^{-26}$ and $4 \pm 2\times10^{-26}$ cm² for Ni, Cu and Zn resp. J. HUGHES

539.172.3

9925. Activation curve of chlorine for the $Cl^{35}(\gamma,n)Cl^{34*}$ reaction near threshold, with the aid of a 22 MeV betatron. R. BASILE, C. SCHUHL AND W. SEBAOUN. *C.R. Acad. Sci.* [*Paris*] **241**, *No.* 4, 387–9 (*July* 25, 1955) In French.

The activation curve exhibits "breaks" at 13·13, 13·51, 13·72, 13·89 and 14·10 MeV (all ±0·07 MeV). The threshold is 12·79 ± 0·07 MeV. J. J. WILKINS

539.172.4

9926. The thermal neutron absorption cross-sections of U^{238} and Th^{232}. V. G. SMALL. Letter in *J. nuclear Energy*, **1**, *No.* 4, 319–20 (*June*, 1955).

These were measured in the BEPO oscillator by comparison with that of Mn: $\sigma_{U^{238}} = 2\cdot76 \pm 0\cdot06$ and $\sigma_{Th^{232}} = 7\cdot31 \pm 0\cdot12$ barns. A. O. STANESBY

539.172.4

9927. Disintegration of carbon into three alpha particles by 12–20 MeV neutrons. G. M. FRYE, JR, L. ROSEN AND L. STEWART. *Phys. Rev.*, **99**, *No.* 5, 1375–84 (*Sept.* 1, 1955).

The reaction $C^{12}(n,n'3\alpha)$ has been studied in C-2 emulsions exposed to fifteen discrete neutron energies in the range 12·3–20·1 MeV. Measurements were made of the range and space angles of the three α-particles for over 2000 events. The observed cross-section is 78 ± 15 mb at 12·6 MeV, goes through a broad maximum of 265 ± 47 mb at 16·9 MeV, and is 223 ± 40 mb at 20·1 MeV. It was found that not all the events are observed in the emulsion since (*a*) one prong may be too short and (*b*) two prongs which arise from the ground state of Be^8 may not be resolvable. A correction is made for these missed stars at four points giving: $\sigma_{corr} = 190 \pm 50$, 230 ± 50, 316 ± 73 and 283 ± 59 mb at the bombarding energies of 12·9, 14·1, 15·5 and 18·8 MeV, respectively. Evidence is found for the excitation of

the 9·6 MeV level in C^{12} and the ground state and 3 MeV level in Be^{8}, so that at least some of the events disintegrate via the mode $C^{12}(n, n')C^{12*}(\alpha)Be^{8*}(2\alpha)$. Six events appear to involve the 7·7 MeV level in C^{12}. The centre-of-mass energy spectrum of the scattered neutrons may be fitted by a four-particle phase space distribution or a Maxwellian distribution. As a result of these measurements, carbon stars in nuclear track plates may be used as a neutron monitor with an accuracy of 15% at 14 MeV and 20% elsewhere in the 12–20 MeV range. A.

539.172.4

9928. Inelastic neutron scattering in F^{19}. J. M. FREEMAN. *Phys. Rev.*, **99**, *No.* 5, 1446–7 (*Sept.* 1, 1955).

The energies and yields of the γ-rays following inelastic neutron scattering in F^{19} have been studied as a function of neutron bombarding energy up to 2·2 MeV. In this range four γ-rays only, of energies $111 \pm 1{\cdot}5$ keV, 196 ± 2 keV, $1{\cdot}240 \pm 0{\cdot}015$ MeV and $1{\cdot}371 \pm 0{\cdot}016$ MeV, have been found. The first two correspond to the first two excited states of F^{19}. The second pair of γ-rays appear, from the threshold curves, to arise from F^{19} levels at $1{\cdot}43 \pm 0{\cdot}03$ and $1{\cdot}55 \pm 0{\cdot}03$ MeV respectively. The alternative of a 1·35 MeV level and the decay scheme are discussed. A.

539.172.4

9929. *n-p* scattering at 300 MeV. J. DE PANGHER. *Phys. Rev.*, **99**, *No.* 5, 1447–57 (*Sept.* 1, 1955).

An investigation of the protons scattered by 300 MeV neutrons has been conducted with a Wilson cloud chamber filled with hydrogen at a gas pressure of ten atmospheres. The data obtained cover the range of angles 10°–180° for the neutrons in the centre-of-mass system. A striking deviation from symmetry appears in that backward scattering is considerably larger than forward scattering. The energy spectrum is presented for the neutrons that are produced in a 1¾ in.-thick LiD target by 340 MeV protons. A few cases of meson production are noted. Also, there is presented experimental evidence for the radiative capture of high-energy neutrons in hydrogen. A.

539.172.4 : 539.166

9930. Gamma radiation from the interaction of 4·4-MeV neutrons with Fe^{54} and Fe^{56}. R. M. SINCLAIR. *Phys. Rev.*, **99**, *No.* 5, 1351–2 (*Sept.* 1, 1955).

The γ-radiation from the interaction of $4{\cdot}4 \pm 0{\cdot}1$ MeV neutrons with naturally occurring iron has been compared with that from a sample enriched to 34% Fe^{54}. The methods used for detection of γ-rays from small samples and the shielding of the NaI detector are described. The results show that the well-known 0·85 MeV γ-ray comes from Fe^{56}, and that Fe^{54} emits a γ-ray of energy $1{\cdot}40 \pm 0{\cdot}02$ MeV. The ratio of the cross-section for production of this 1·40 MeV radiation to that of the 0·85 MeV is $0{\cdot}62 \pm 0{\cdot}07$ at 4·4 MeV neutron energy, and $0{\cdot}68 \pm 0{\cdot}10$ at 3·9 MeV. The 1·40 MeV γ-ray is tentatively assigned to the reaction $Fe^{54}(n, n')Fe^{54*}(\gamma)Fe^{54}$, and is believed to represent the de-excitation of the first excited state. A.

539.172.4 : 532.696.1

The significance of wetting in reactor technology. *See Abstr.* 9464

539.172.4

9931. Thermal neutron-fission cross-section of uranium 233. D. POPOVIĆ AND E. SAELAND. *J. nuclear Energy*, **1**, *No.* 4, 286–9 (*June*, 1955).

5 μg of U^{233}, obtained by chemical separation from neutron irradiation of Th were irradiated in the thermal neutron column of the JEEP reactor; the neutron flux was obtained from measurements on crystals of NaI irradiated simultaneously. The ratio: fission cross-section of U^{233}/activation cross-section for Na = 985 ± 3%, giving $\sigma_{fiss} = 492 \pm 25$ barns for $\sigma_{Na} = 0{\cdot}50$ barns. A. O. STANESBY

539.172.4

9932. The spherical harmonics method in plane and spherically symmetric geometry in multi-velocity-group theory, and its application in the two-velocity-group P_3 approximation. M. E. MANDL. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. No. T/R* 1295, 14 *pp.* (1953).

The spherical harmonics method is extended to a multi-velocity-group theory and is illustrated by application to a two-velocity group theory in P_3 approximation, in spherical and in plane symmetrical geometry. The method is applied, in the 2-group P_3 approximation, to finding the critical radius of a spherical core surrounded by a tamper of uniform thickness, and the critical thickness of an infinite slab core with equal thicknesses of tamper on each side. A.

539.172.4

9933. The Swedish heavy water reactor—two kinetic experiments. E. HELLSTRAND. *Atomics* [*London*] **6**, *No.* 7, 187–94 (*July*, 1955).

The prompt neutron lifetime in the Swedish heavy water reactor was determined by two standard methods, the first involving analysis of phase and amplitude modulation of the power level resulting from a periodic modulation of reactivity, the second involving analysis of the time variation in power following a step change in reactivity. Good agreement was obtained, an effective mean lifetime of neutrons in the reactor medium of $0{\cdot}71 \pm 0{\cdot}03$ msec being obtained. L. R. SHEPHERD

539.172.4

9934. The nuclear reactor with a transverse air gap. J. CHERNICK AND I. KAPLAN. *J. nuclear Energy*, **2**, *No.* 1, 41–51 (*Aug.*, 1955).

Diffusion theory and transport theory treatments of the problem of a nuclear reactor with a transverse air gap are compared. It is suggested that the difference in results for narrow gaps results from the fact that diffusion theory does not adequately represent the flux distribution in the neighbourhood of the gap. For mathematical convenience, previous treatments of the gap problem have involved the use of fictitious image piles which exaggerate the neutron losses. The extent of the error is estimated by direct neutron leakage calculations. Expressions are obtained for the critical size of a reactor with a transverse air gap. A.

539.172.4

9935. A modification to the diffusion theory of the thermal fine structure in a reactor to account for the effect of air channels. D. A. NEWMARCH. *J. nuclear Energy*, **2**, *No.* 1, 52–8 (*Aug.*, 1955).

The ratio of the thermal neutron flux at the air/moderator interface to the flux at the air/metal

interface is calculated for the cases: (*a*) uranium rods set in air channels; (*b*) uranium tubes set in air channels. A.

539.172.4

9936. The specification of neutron flux and nuclear cross-sections in reactor calculations. C. H. WESTCOTT. *J. nuclear Energy*, **2**, *No.* 1, 59–75 (*Aug.*, 1955).

The concepts of the "flux" of neutrons and the target area or "cross-section" to be associated with a particular nucleus are familiar and convenient for calculating the rate at which a specified nuclear reaction will occur. Complexities arise when, as in a thermal reactor, the neutrons vary widely in velocity, since the cross-section also varies with this velocity. This paper examines these problems and considers how an "effective" cross-section may be defined and notes that reactor flux is commonly stated in terms of the neutron density (number per unit volume) multiplied by a conventional velocity (2 200 m/sec). The true flux differs from the value normally used by a numerical factor: although one could avoid the difficulty by working in terms of neutron density instead of flux and replacing cross-section by a new concept, the well established conventions appear worth preserving. Formulae are given for "effective" cross-sections applicable to thermal reactor neutron spectra for a reaction having a simple Breit–Wigner resonance, with numerical examples, and the effect of varying the neutron temperature is considered. A.

539.174.4

9937. Neutron-flux distribution from a thermal-column face. I. G. WEINBERG AND E. R. COHEN. *Nucleonics*, **13**, *No.* 7, 25–7 (*July*, 1955).

Isodose curves are calculated for thermal neutrons emerging from a circular aperture in a thin shield covering the plane face of a thermal column, the flux over the exposed face being assumed constant.

L. R. SHEPHERD

539.174.4

9938. Dual cycle improves boiling-water reactors. S. A. UNTERMYER. *Nucleonics*, **13**, *No.* 7, 34–5 (*July*, 1955).

The maximum permissible steam volume (~20%) in the core of a simple direct boiling-water reactor limits power output to about 10 kW/litre and load demand characteristics in this system are unstable. If the water enters the core subcooled, a much higher power output of 45 kW/litre is possible for the same average steam bubble voidage. The subcooled water would come from a flash tank receiving hot water from the outlet of the reactor core. The main steam at 600 lb/in^2 and 486°F would feed a high pressure turbine, while steam at 350 lb/in^2 and 431°F from the flash tank would feed a low pressure turbine. The load demand characteristics of such a system are stable. L. R. SHEPHERD

ATOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18

9939. Lectures on fundamental particles. B. ROSSI. *Nuovo Cimento Suppl.* (*Ser.* 10) **2**, *No.* 1, 163–226 (1955).

A review article of known data concerning heavy mesons (*K*-particles) and hyperons (*Y*-particles). Conservation laws, kinematics and some experimental techniques are discussed briefly. Extensive tables summarizing information from known events are presented. Possible decay schemes are discussed.

G. E. BROWN

539.18

9940. Classification of the fundamental particles. R. G. SACHS. *Phys. Rev.*, **99**, *No.* 5, 1573–80 (*Sept.* 1, 1955).

The decay and production processes of the pions, *K*-mesons, nucleons and hyperons are classified in terms of selection rules for an integral quantum number, *a*, called the "attribute," which is assigned a definite value for each particle and assumed to be additive when particles are combined. No attempt is made to relate the attribute to other physical properties of the particles. The scheme suggests relationships between processes which have yet to be observed such as the associated production of a cascade particle with two (positive or neutral) *K* mesons. When it is combined with the notion of isotopic spin (*I*) conservation, it suggests the existence of several new particles, the Σ^0 of Gell-Mann and Nishijima, a Ξ^0 and a neutral *K*-meson differing in its properties from the θ^0. Results of isotopic spin assignments suggest the rule (odd-even rule) that even-*a* fermions have half-integral *I*, odd-*a* fermions have integral *I*, and conversely for the bosons. There are also implications concerning the interactions between various particles: the range of the potential binding the Λ^0 to a nucleon should be of the order of the *K*-meson Compton wavelength. The classification is extended to include electrons, neutrinos and muons with the result that their attributes must be half-integral. In order to exclude certain unobserved processes, it is necessary to assume that the neutrino is the source of the weak (Fermi) interaction of fermions, in contrast to the notion of the universal Fermi interaction. The existence of an antineutrino is strongly suggested. The $K_{\mu 3}$ and K_{e3} (considered as one particle) may be interpreted as a boson (*K*) or fermion (κ). In the former case, the decay schemes $K^{\pm} \rightarrow e^{\pm} + \nu$, $K^0 \rightarrow 2\nu$ and $K^0 \rightarrow \pi + \mu + \nu$ are expected to occur. In the latter case, production of the κ through the decay process $K \rightarrow \kappa + \nu$ is suggested. Several unusual new events are classified in order to illustrate the method. A table of thresholds for production of the various particles is included in an Appendix. No excuse is offered for the non-occurrence of $\pi - e$ decay. A.

539.18

9941. On the possible existence of degenerate charged states of heavy unstable bosons in the Gell-Mann–Pais theory. N. DALLAPORTA AND L. TAFFARA. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 3, 418–24 (*Sept.*, 1955).

It is studied under what assumption degenerate charged states of heavy unstable bosons may exist in the framework of the Gell-Mann–Pais theory [Abstr. 6489 (1955)] which should be invariant with opposite parities under combined operations of charge conjugation and charge symmetry, so that they should undergo different and mutually exclusive decay processes. It is found that such degenerate states may exist only if one assumes the third scheme of

hyperonic levels of Gell-Mann–Pais, which postulates more Λ and Σ charged states than are up to now experimentally known, and moreover only if one postulates that reactions between nucleons, which should give associated production of hyperons, are always forbidden. A.

539.18 : 537.591.8

9942. On the plural-multiple model of high energy meson showers. Y. TERASHIMA. *Progr. theor. Phys.*, **13**, *No.* 1, 1–12 (*Jan.*, 1955).

The internuclear cascade on the basis of the multiple theory of meson production is investigated in view of the so-called cosmic-ray jet. The implication of Fermi's and Heisenberg's theories in this picture of the cascade is discussed purely on the kinematical ground. The predominant role in meson production of the successive collisions is played by many-body collisions in the case of Fermi's theory, while by the simple nucleon–nucleon collision in Heisenberg's. The tunnel approximation of jets is shown to be applicable in these cases at sufficiently high energies. The criterion of this approximation is given by calculating the number of mesons which get off the tunnel. The possibility of accompanying grey tracks besides evaporation particles arises from these low energy mesons. The anisotropy in the angular distribution of jet particles, is shown to be stronger in Fermi's model than in Heisenberg's model. The present experimental evidences are too meagre to choose one of these theories, but seem favourable to Fermi's theory rather than to Heisenberg's. A.

539.18

9943. Mesonic decay of a singly charged fragment. F. ANDERSON, G. LAWLOR AND T. E. NEVIN. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 3, 605–7 (*Sept.*, 1955).

The results of measurements on a meson-active fragment event found in photographic emulsions are given. The event can be interpreted as the mesonic decay of either a H^3 or H^4 nucleus, containing a bound Λ^0-particle in place of a neutron. In either case, the binding energy of the Λ^0-particle is found to be $-0{\cdot}7 \pm 0{\cdot}8$ MeV. A.

539.18

9944. Charge independence in light hyperfragments. R. H. DALITZ. *Phys. Rev.*, **99**, *No.* 5, 1475–7 (*Sept.* 1, 1955).

The study of binding energies of light hyperfragments may provide a quantitative test of Gell-Mann's proposal to describe the Λ^0-particle as an isotopic-spin singlet. Specific predictions are that ${}_1H^{4*}$ should exist with the same B_Λ as for ${}_2He^{4*}$ and that B_Λ for ${}_2He^{3*}$, if this exists, should not exceed B_Λ for ${}_1H^{3*}$. A.

539.18

9945. Disintegration of hyperfragments. W. F. FRY, J. SCHNEPS AND M. S. SWAMI. *Phys. Rev.*, **99**, *No.* 5, 1561–72 (*Sept.* 1, 1955).

A systematic search has been made for events which appear to be due to the disintegration of a hyperfragment; that is, a nuclear fragment which contains a bound unstable particle. A total of 20 000 3 BeV proton stars and 500 1·5 BeV π^--meson stars from the Brookhaven Cosmotron were studied as well as 9 000 cosmic-ray stars. Twenty-one events which are interpreted as hyperfragments were found in the proton plates, seven in the cosmic-ray plates and one in the π-meson plates. Of the 29 disintegrations, a π-meson was ejected in only two cases and a K-meson in one event. In the remaining 26 disintegrations, only nuclear particles were emitted. The charge and energy distributions, as well as the angular distribution of the hyperfragments, have been measured. In four cases the energetics of the decay strongly indicate that the bound unstable particle was a Λ^0-particle. The binding of the Λ^0-particle was measured in these cases. In two additional cases the minimum energy release was significantly greater than the decay energy of a Λ^0-particle but possibly consistent with the decay energy of a charged hyperon. In one case a negative K-meson was ejected from a secondary star. It is impossible to determine whether this secondary star was due to a fragment disintegration or the nuclear capture of a stopped particle. This event cannot be explained in terms of established unstable particles. A.

539.18

9946. Two examples of a star emitting two heavy unstable particles. A. DEBENEDETTI, C. M. GARELLI, L. TALLONE AND M. VIGONE. *Nuovo Cimento Suppl.* (*Ser.* 10) **2**, *No.* 1, 249–52 (1955).

The first is a star of type $21 + 7p$ from which a positive τ-meson and an excited fragment are emitted. The unstable fragment disintegrates at rest into two charged particles and can be interpreted as: ${}^3H_1^* \rightarrow {}^3He_2 + \pi^- + 42$ MeV. In the second case a K-meson and a neutral particle decaying in flight are ejected from a star of type $27 + 9p$. The K-meson is probably a $K_{\mu 3}$, it is not possible, however, to decide if the neutral particle is a θ^0 or a Λ^0 from an analysis of the V-event. D. J. PROWSE

539.18

9947. Unstable fragments. R. L. SETTI. *Nuovo Cimento Suppl.* (*Ser.* 10) **2**, *No.* 1, 263–74 (1955).

A review of the evidence on unstable fragments emitted from cosmic-ray stars in nuclear emulsion. Most examples can be explained by the decay of a Λ^0-particle bound to the fragment in place of a neutron. The lifetimes, the energy spectrum of the nucleons emitted in the decay, the energy released and the binding energy of the Λ^0 in the fragment, are considered. D. J. PROWSE

539.18

9948. Observations on unstable fragments. C. CASTAGNOLI, G. CORTINI AND C. FRANZINETTI. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 3, 550–64 (*Sept.*, 1955).

Six events interpreted as disintegrations of hyperfragments are described. Five of these are associated with releases of energy which are consistent with the values measured by other authors and all could be interpreted as system of nucleons containing a Λ^0. One can only be interpreted assuming that the bound hyperon is a Ξ^- or a more massive particle. This hyperfragment is emitted from a star from which a K-particle is also emitted. The hypothesis of a bound Ξ^- is briefly discussed together with possible disintegration schemes and the Q-values relative to them. A.

539.18

9949. *K*-meson and hyperon events. C. Castagnoli, G. Cortini and A. Manfredini. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 3, 565–73 (*Sept.*, 1955).

Twenty-one *K*-meson and five hyperon events observed in Rome are described. Detailed discussion is given of the probable interaction of a negative hyperon at rest and of the decay in flight of a hyperon which shows a *Q*-value of 71 ± 5 MeV and is interpreted as due to a Ξ-particle. A.

539.18

9950. Analysis of τ-mesons. P. S. Goel and K. A. Neelakantan. *Proc. Indian Acad. Sci. A*, **42**, *No.* 1, 22–7 (*July*, 1955).

Describes measurements made on the decay products of 11 τ-mesons observed in large nuclear emulsion block detectors. Out of the 33 charged decay products, 27 have been arrested in the block, and were identified as π-mesons. The charge of the τ-meson was found to be positive in 6 cases. In one case the charge of the τ-meson is possibly negative and in 4 cases it could not be determined. Omitting one τ-meson in which a high-energy γ-ray is emitted and which has been reported earlier the weighted mean *Q*-value of the remaining 10 τ-mesons is $Q_\tau = 76{\cdot}3 \pm 0{\cdot}3$ MeV, which gives the mass of the τ-meson as $m_\tau = 968{\cdot}7 \pm 0{\cdot}6\, m_e$. This value is slightly higher than the mean value $965{\cdot}5 \pm 0{\cdot}7\, m_e$ compiled by Amaldi *et al.* from measurements of various laboratories. A.

539.18

9951. Search for the β-decay of the pion. S. Lokanathan and J. Steinberger. *Nuovo Cimento Suppl.* (*Ser.* 10) **2**, *No.* 1, 151–62 (1955).

Counters discriminate between electrons from π- and μ-decays. It is found that it is unlikely that the ratio of $\pi \to e + \nu$ to $\pi \to \mu + \nu$ exceeds $0{\cdot}6 \times 10^{-4}$. If the pion were coupled symmetrically to the muon and to the electron, the theory would predict a higher rate, even in the most unfavourable (axial vector coupling) case. G. E. Brown

539.18

9952. Results on heavy mesons. M. Ceccarelli. *Nuovo Cimento Suppl.* (*Ser.* 10) **2**, *No.* 1, 227–30 (1955).

Results of the Padua nuclear emulsion group on *K*-meson decay and nuclear capture of negative *K*-mesons are presented. It is concluded that a decay scheme $K_{\pi 2} \to \pi^+ + \pi^0$ is probable. G. E. Brown

539.18

9953. Comparison of results on *K*-particles disintegrating at rest in cloud chambers and photoemulsions. C. Dilworth and B. Rossi. *Nuovo Cimento Suppl.* (*Ser.* 10) **2**, *No.* 1, 239–46 (1955).

An attempt is made to reconcile the decay spectra given by the two instruments by postulating the least possible number of different decay schemes (omitting the normal and alternative decay modes of the τ). A one-particle scheme: $K_{\mu 3} \to \mu + \nu + \gamma$ cannot possibly explain the results obtained and a two-particle scheme: $K_{\mu 3} \to \mu + \nu + ?$ and $K\pi_2 \to \pi + \pi^0$ is not much better. Indeed it appears the results need a 3-particle scheme, the $K_{\mu 2} \to \mu + \nu$ providing the 3rd-particle decay scheme. One has also to assume that the alternate modes or particles do not appear in the same ratio in the two instruments, in plates the ratio is: $N_{K\mu 3} \approx N_{K\pi 2} \approx N_{K\mu 2}$ and in cloud chambers: $N_{K\mu 2} > N_{K\pi 2} \gg N_{K\mu 3}$. D. J. Prowse

539.18

9954. Statistical evidence concerning the χ-meson decay. N. Dallaporta. *Nuovo Cimento Suppl.* (*Ser.* 10) **2**, *No.* 1, 247–8 (1955).

Collecting together all the examples of *K*-decay in which there is evidence that the secondary is a π-meson, it becomes apparent that the secondary has a unique $p\beta$ of about 167 MeV/c (accurately $167{\cdot}5 \pm 6$). If we assume that the secondary neutral particle of the decay is a π^0, the *Q*-value is 215 ± 8 MeV and the mass of the χ is $960 \pm 18\, m_e$ which fits with the mass of the θ-particle and suggests that the χ is its charged counterpart. D. J. Prowse

539.18

9955. Diffusion cloud-chamber study of very slow mesons. II. Beta decay of the muon. C. P. Sargent, M. Rinehart, L. M. Lederman and K. C. Rogers. *Phys. Rev.*, **99**, *No.* 3, 885–90 (*Aug.* 1, 1955).

For Pt I, see Abstr. 7389 (1955). The spectrum of electrons arising from the decay of the negative μ-meson has been determined. The muons are arrested in the gas of a high-pressure hydrogen-filled diffusion cloud chamber. The momenta of the decay electrons are determined from their curvature in a magnetic field of 7750 gauss. The spectrum of 415 electrons has been analysed according to the theory of Michel. The shape parameter, ρ, is found to be $0{\cdot}64 \pm 0{\cdot}10$. The significance of this result in terms of the β interaction is discussed. A.

539.18

9956. Gamma stability of *K*-mesons. S. B. Treiman and H. W. Wyld, Jr. Letter in *Phys. Rev.*, **99**, *No.* 3, 1039–40 (*Aug.* 1, 1955).

The observed stability against γ-decay of two strongly coupled *K*-mesons may be accounted for, either by the masses being almost identical, or by the spins being either both zero or very different from each other. P. T. Matthews

539.18

9957. On the $K_{\mu 3}$- and $K_{\beta 3}$-decay schemes. G. Costa and N. Dallaporta. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 3, 519–25 (*Sept.*, 1955).

In order to explain the three-body decays of *K*-particles according to the reactions: $K_{\mu 3} \to \mu + \nu + \pi^0$, $K_{\beta 3} \to \beta + \nu + \pi^0$, a detailed decay scheme is proposed which seems to be the simplest possible for obtaining for both these decays a lifetime of the same order of magnitude as the χ-decay lifetime. This scheme is based on the assumption of both the strong Gell-Mann–Pais interaction between *K*-particles and hyperons, and the possibility for hyperons to suffer μ- and β-decays regulated by the weak universal Fermi interaction constant. A.

539.18

9958. Unusual decay of a χ-meson. F. Anderson, G. Lawlor and T. E. Nevin. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 3, 608–12 (*Sept.*, 1955).

An event is described in which a χ-meson decays at rest to three charged particles, two of which are electrons. Details of the measurements are given and are consistent with the interpretation of a χ-meson

decay involving a π^0-meson which undergoes anomalous decay to two electrons and a photon. A.

539.18

9959. β decay of *K*-mesons and the classification of *K*-meson decays. M. F. KAPLON, J. KLARMANN AND G. YEKUTIELI. *Phys. Rev.*, **99**, *No.* 5, 1528–33 (*Sept.* 1, 1955).

Three well-identified cases of *K*-electron decay have been observed at Rochester. The secondary electrons range in energy from 20 to 261 MeV, showing that the decay involves at least 3 particles. The available data on *K*-meson decays observed in nuclear emulsion is analysed from the point of view of asking how many of the secondaries are consistent with the assumption that they are μ-mesons from the $K_{\mu 3}$-decay or electrons from the K_{e3}-decay. It is found that an appreciable fraction ($\sim\frac{1}{3}$ to $\frac{1}{2}$) of the observed decays are consistent with this assignment. The observed branching ratio is consistent with that deduced from a Fermi interaction, but the lifetime predicted on the basis of a universal Fermi interaction seems shorter than that suggested by the observations in emulsion. It is concluded that the existing data on *K*-mesons is consistent with the assumption that there exists at least five separate decay schemes and that it is possible for each case to consider the parent *K*-meson as having integral spin. A.

539.18

9960. Angular correlation in the decay of τ-mesons. H. WINZELER. *Helv. phys. Acta*, **28**, *No.* 4, 347–8 (1955) In German.

By examining the angle between the plane containing the 3π-mesons from the decay of τ-mesons and the initial direction of the τ-mesons from the parent star, it might be possible to detect a polarization. Should such a polarization exist it would indicate that the spin of the τ-meson was greater than zero, if not, it is not possible to place any limits on the spin. Twenty τ-meson decays have been examined and a histogram plotted of the angle between the initial τ-direction and the normal to the plane of decay. On these very small statistics it is impossible to draw a definite conclusion but the ratio of those angles below 60° to those above (=1 for isotropy), is $1{\cdot}5 \pm 0{\cdot}7$ indicating a slight tendency towards polarization. D. J. PROWSE

539.18

9961. The determination of the masses of heavy mesons and hyperons by the photometry of their tracks in nuclear emulsions. L. VAN ROSSUM. *Ann. Phys.* [*Paris*] **10**, 643–92 (*July–Aug.*, 1955) In French.

A thesis in which the problems of measuring the ionization produced by heavy mesons and hyperons by photometric means are fully discussed. Apparatus has been constructed and is described, which gives an accuracy of about 7%. Numerous factors which previously limited the success of the method have been overcome by careful background corrections, by calibrating the degree of development throughout the emulsion and by taking into account the apparent decrease in the transparency of the emulsion with depth. The apparatus has been used to measure the masses of several *K*-mesons found in the Bristol laboratory. They all have masses slightly greater than, but within a standard deviation of, the mass of the τ-meson. D. J. PROWSE

539.18

9962. Analytical method for obtaining phase shifts from experimental data on pion–proton scattering. E. CLEMENTEL, G. POIANI AND C. VILLI. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 3, 389–96 (*Sept.*, 1955).

The method is outlined and as an example phase shifts for $\pi^+ \rightarrow \pi^+$ scattering at 120, 135 and 300 MeV are calculated. The graphical application of this method gives the working principle of a mechanical phase-shift analyser. A.

539.18

9963. Observations on the Coulomb interference of $\pi^+ + p$ scattering. E. PEDRETTI, A. STANGHELLINI AND G. QUARENI. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 3, 450–5 (*Sept.*, 1955) In Italian.

Using the experimental data so far available, the behaviour is traced for energy up to 150 MeV, of the scattering phase-shifts α_3 and α_{33}. α_{31} is considered negligible in this energy interval. From these phase shifts, the most favourable energy for an experiment which could reveal the Coulomb interference, and therefore the signs of the phase shift, has been determined. The optimum value of the energy is around 120 MeV. Up to now, two experimental determinations exist at 113 and 120 MeV, obtained with photographic plates. The differential cross-section obtained from these, based on a total of 782 events, corresponds to an average energy of 117 MeV; it clearly shows that the Coulomb interference must be destructive. The phase shifts found, according to Fermi's solution, are: $\alpha_3 = -(11{\cdot}1 \pm 1{\cdot}0)^0$, $\alpha_{33} = (31{\cdot}5 \pm 2{\cdot}1)^0$, $\alpha_{31} = -(0{\cdot}6 \pm 1{\cdot}8)^0$. This solution in comparison to the one obtained by changing all the signs of the phase shifts, is statistically preferable by a factor of 1 360. A.

539.18

9964. Absorption experiments involving heavy mesons. T. D. LEE. Letter in *Phys. Rev.*, **99**, *No.* 1, 337–8 (*July* 1, 1955).

Some experiments on the absorption of heavy mesons by protons, deuterons and He^4 are suggested, which would give evidence on the spin of these particles, and the validity of the charge independence hypothesis for strong interactions. P. T. MATTHEWS

539.18

9965. Interactions of K^--mesons at rest. E. LOHRMANN, C. PEYROU, M. TEUCHER AND H. WINZELER. *Helv. phys. Acta*, **28**, *No.* 4, 346–7 (1955) In German.

Three events have been found which can be identified as interactions of K^--mesons at rest. The first K^- was emitted from an 18 + 1 star and resulted in a 3-particle σ_K-star, one of these was a recoil particle and the other two protons. 27 μ from the σ_K-star, a V_0 event has been found consisting of a π-meson and a proton. The direction of the V_0 and the star are co-incident to within $\pm 0{\cdot}5°$. The visible energy in the star was 300 ± 10 MeV. The parent-stars of the K^--mesons have been examined for the presence of other *K*-mesons or hyperons without success. D. J. PROWSE

539.18

9966. Interaction between *K*-particles and nucleons. A. Pais and R. Serber. *Phys. Rev.*, **99**, *No.* 5, 1551–5 (*Sept.* 1, 1955).

Some consequences of the strong interactions between *K*-particles and nucleons are discussed. A connection is noted between the associated production mechanism and spatial exchange characteristics of *K*-nucleon scattering. (The same is true for Λ^0-nucleon scattering.) The *K*-nucleon interactions may possibly lead to bound states of *K*-particles in nuclear matter ("*K*-fragments"). If a θ^0-fragment exists, its decay modes are 2-, 1-, or 0-mesonic. It is estimated that the former two modes would have comparable probabilities, while the last one is less probable by a factor $\sim 0{\cdot}005$ if the spin of the θ^0 is zero, or by a factor $\sim 0{\cdot}05$ if the spin is 1. The results may have bearing on the interpretation of fragments with energy release larger than corresponds to a bound Λ^0. A.

539.18

9967. An unstable fragment produced on the nuclear capture of a hyperon. M. Ceccarelli, N. Dallaporta, M. Grilli, M. Merlin, G. Salandin, B. Sechi and M. Ladu. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 3, 542–9 (*Sept.*, 1955).

An event is described which consists in a slow singly charged particle of superprotonic mass, coming to rest in the emulsion and giving rise to an excited fragment and no other visible secondary; after a range of 46 μm, the fragment disintegrates into a proton of 110 MeV and a singly charged particle with a range of 300 μm, which may be either a proton or a deuteron. The event is consistent with the assumption that a negative hyperon captured by a nucleus interacts according to reaction: $\Sigma^- + P \rightarrow \Lambda^0 + N$, the Λ^0 remaining bound into an unstable nuclear fragment. All other hyperon capture events known up to now are discussed in order to see if they could be interpreted as being due to the same reaction. A.

539.18

9968. The production of mesons in very high energy collisions. W. Heisenberg. *Nuovo Cimento Suppl.* (*Ser.* 10) **2**, *No.* 1, 96–103 (1955).

Recording of a lecture reviewing the theory of Landau in comparison with the theories of Fermi and the author, and with experiment. P. T. Matthews

539.18

9969. Reaction $p + p \rightarrow \pi^+ + d$ with polarized protons. F. Mandl and T. Regge. *Phys. Rev.*, **99**, *No.* 5, 1478–83 (*Sept.* 1, 1955).

The reaction $p + p \rightarrow \pi^+ + d$ is analysed. Using the statistical operator methods, the authors derive: (i) the production cross-section for *s*-, *p*- and *d*-wave mesons for the case of a polarized proton beam; (ii) the polarization of the deuteron for both polarized and unpolarized incident protons. With the restriction to *s*- and *p*-waves, the deuteron polarization gives new information about the production amplitudes; for an unpolarized proton beam for the *p*-wave production only, for a polarized one for *s*-waves as well. The possibilities of measuring the deuteron polarization and the relation of the phases of the production amplitudes to the *pp*-scattering phases are discussed. A.

539.18

9970. Pion production by neutrons on helium. P. H. Moulthrop. *Phys. Rev.*, **99**, *No.* 5, 1509–14 (*Sept.* 1, 1955).

A helium-filled 36-atmosphere diffusion cloud chamber in a pulsed 21 000 gauss magnetic field was operated in the 300 MeV neutron beam of the 184 in. cyclotron. Two hundred and ninety-five negative pions were found, with associated prongs as indicated in the table.

Reaction	*Percent*
$n + \alpha \rightarrow \alpha + p + \pi^-$	$5{\cdot}7 \pm 1{\cdot}4$
$n + \alpha \rightarrow p + He^3 + n + \pi^-$	$32{\cdot}0 \pm 3{\cdot}3$
$n + \alpha \rightarrow \left\{ \begin{matrix} \alpha + p + \pi^- \text{ or} \\ p + He^3 + n + \pi^- \end{matrix} \right\}$	$4{\cdot}6 \pm 1{\cdot}2$
$n + \alpha \rightarrow d + He^3 + \pi^-$	$30{\cdot}4 \pm 3{\cdot}2$
$n + \alpha \rightarrow p + p + d + n + \pi^-$	$15{\cdot}4 \pm 2{\cdot}3$
$n + \alpha \rightarrow d + d + p + \pi^-$	$6{\cdot}2 \pm 1{\cdot}5$
$n + \alpha \rightarrow t + p + p + \pi^-$	$3{\cdot}3 \pm 1{\cdot}1$
$n + \alpha \rightarrow p + p + p + n + n + \pi^-$	$1{\cdot}8 \pm 0{\cdot}8$
$n + \alpha \rightarrow$ unclassified $+ \pi^-$	$0{\cdot}6 \pm 0{\cdot}4$
Total	100·0

A comparison is drawn between these results and the cross-sections measured by Tannenwald for 90 MeV neutrons on helium. The comparison shows (*a*) the probability of the α-particle's being broken up is much larger in the pion-production experiment, indicating the importance of large momentum transfers in pion production, (*b*) there are many more fast deuterons associated with pion production than pickup deuterons in the 90 MeV experiment, (*c*) the other inelastic cross-sections are in good agreement if the principle of charge symmetry is invoked. The energy distribution of the mesons is in good agreement with that found in a similar experiment with an oxygen-filled chamber. The angular distribution of the pions is also similar to that obtained by other investigators. Two cases of neutral pion production were detected by the π^0's decay into an electron pair and one γ-ray. One example of triplet production, $\gamma + e^- \rightarrow e^+ + e^- + e^-$, was observed. A.

539.18

9971. Production of π^+ mesons at 0° by 335-MeV protons on deuterium and complex nuclei. J. Merritt and D. A. Hamlin. *Phys. Rev.*, **99**, *No.* 5, 1523–8 (*Sept.* 1, 1955).

The relative yield of π^+-mesons has been determined for 335 MeV protons on several elements. Specifically, the relative differential cross-section, $d^2\sigma/dE\,d\Omega$, was measured at $0° \pm 4°$ in the reaction $p + A \rightarrow \pi^+ + A'$ for D, Be^9, B^{10}, B (natural), C, Al, Cu, Fe, Ag and Pb. The π^+-meson energies ranged from 34 to 147 MeV. They were counted electronically from signals generated in a *trans*-stilbene crystal telescope. Identification of the π^+-meson depended upon a coincidence in the first two crystals plus the $\pi^+ - \mu^+$ decay in the third crystal of the telescope. No special isotope effects were observed for the π^+-meson spectra from the isotopes Be^9, B^{10}, B (natural) and C. For C, Cu and Pb the relative π^+-meson yield per nucleus is proportional to the product of two factors, (*a*) the number of protons in the nucleus, (*b*) an attenuation factor F which is derived from proton

and meson mean free paths in nuclear matter. These mean free paths are consistent with those calculated from measured interaction cross-sections of protons and mesons with C, Cu and Pb. The importance of meson scattering within nuclear matter is discussed in the case of carbon. Also the total π^+-meson production is estimated for carbon from the experimental proton-proton cross-section and is compared with the experimental results for carbon. A.

539.18

9972. Simple nonrelativistic model for single meson production. D. A. GEFFEN. *Phys. Rev.*, **99**, *No.* 5, 1534–41 (*Sept.* 1, 1955).

Single pseudoscalar meson production is assumed to be described by a transition matrix element taken between initial and final two-nucleon wave-functions defined as solutions to Schrödinger's equation with a phenomenological potential included. The effective interaction is a linear combination of the two possible nonrelativistic invariants. The angular distribution and energy dependence is considered in detail for the reaction $p + p \rightarrow \pi^+ + d$. Using the Jastrow potential to define the proton wave functions, the large anisotropy can be explained by including the *D* state of the deuteron. Results become less satisfactory at increasing energies. The predicted energy dependence of the total cross-section for proton beam energies from 311 MeV to 515 MeV agrees well with experiment. The strong dependence of the cross-section on the incident proton momentum contributes to the agreement. An order of magnitude estimate of the alternate reaction, $p + p \rightarrow \pi^+ + n + p$, predicts, at 340 MeV (laboratory system), a branching ratio slightly greater than one. Finally, the absorption rate of π^--mesons by deuterons from a *K*-shell orbit, i.e. $\pi^- + d \rightarrow 2n$, is calculated. This gives an estimate of the strength of the *S*-meson wave part of the interaction and is consistent with the restrictions imposed by the results obtained for the reaction $p + p \rightarrow \pi^+ + d$. A.

539.18

9973. Analysis of properties of secondary particles in nucleon-nucleon collisions at very high energy. R. G. GLASSER, D. M. HASKIN, M. SCHEIN AND J. J. LORD. *Phys. Rev.*, **99**, *No.* 5, 1555–60 (*Sept.* 1, 1955). *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 3, 647–57 (*Sept.*, 1955).

Momentum measurements were made on the individual secondary particles emitted in the "outer" cone of the *S*-star. A lower limit to the momentum of the particles in the "inner" cone was obtained. The transformation from the laboratory system to the centre-of-mass system can be made, using suitable approximations, on the assumption that all charged secondaries are pions. This leads to a symmetrical angular and energy distribution with all particles included in a forward or backward cone of half-angle 20°. The results are compared with various multiple production theories. It is possible to infer that there is no more than one pair of particles of protonic mass among the secondaries and that even the presence of one pair would violate symmetry. The number of *K*-mesons must also be small. The methods of analysis should be useful on other events in this energy range. A.

539.181

9974. The diffuse reflexion of silver atoms at a metallic target at high temperature. S. CHOMET AND J. YARWOOD. *Brit. J. appl. Phys.*, **6**, *No.* 10, 343–6 (*Oct.*, 1955).

Experiments on the diffuse reflection of metallic atoms at solid surfaces have hitherto been conducted only with mercury and the alkali metals, and at target temperatures not exceeding 600°C. To study such reflection at temperatures of about 1 000°C, using silver atoms, a special type of atom "gun" has been constructed and an autoradiographic technique employed where the silver used was highly enriched with radioactive silver, Ag^{110}. The measurements show that Knudsen's cosine law applies at these elevated temperatures. A.

539.185

9975. Moderation and diffusion of neutrons from a localized pulsed source. J. B. SYKES. *J. nuclear Energy*, **2**, *No.* 1, 31–7 (*Aug.*, 1955).

Using a polynomial expansion method, the mean time of arrival, and the variance about that mean, are found for various energies and various distances from a pulsed plane source of fast neutrons. The results are evaluated for two media. The corresponding quantities are also derived, using diffusion theory, for thermal neutrons from a pulsed point source of fast neutrons. A.

539.185

9976. Pulsed neutron source. E. F. MARTINA AND V. J. ASHBY. *Rev. sci. Instrum.*, **26**, *No.* 9, 878–9 (*Sept.*, 1955).

A pulsed neutron source is described which gives 10^6 neutrons in a burst which is 2×10^{-8} sec wide. The plasma of an ion pump is used as the source of deuterium ions which are accelerated to 200 kV before striking a deuterium target, where the $D(d, n)He^3$ reaction produces 2 to 3 MeV neutrons. A.

539.185

9977. The scattering of neutrons by the walls of a laboratory. M. B. BIRAM AND J. H. TAIT. *Atomic Energy Res. Establ.* [*Harwell*] *Rep.* T/R563, 16 *pp.*; corrigendum 3 *pp.* (1950).

The flux of neutrons scattered back to the source is calculated for the following cases: (1) a source placed over a semi-infinite non-capturing medium, corresponding to earth's surface; (2) a source placed in the gap between two semi-infinite non-capturing media; (3) a source placed in a spherical room, for the cases when the source is at the centre or is slightly off centre. A.

539.185.08

9978. Flux measurements of fast neutrons with a recoil counter in the energy range of 50–2 000 keV. W. D. ALLEN AND A. T. G. FERGUSON. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. No. NP*/R1720, 11 *pp.* (1955).

The self-consistency of the measurements for different counters filled with H_2 or CH_4 at different pressures is 2–3%. The measurement was cross-checked at 200 keV by comparison with two RdTh–D_2O sources of identical construction but widely differing intensities; the agreement was within 1% and 2% respectively. This report describes the

details of the experimental studies undertaken in the course of the work. A.

539.185.08

9979. Feasibility of a proposed method of measurement of intermediate neutron spectra. J. B. SYKES. *Atomic Energy Res. Establ.* [*Harwell*] *Mem. T/M*115, 10 *pp.* (1955).

Provisional results are given regarding the possibility of measuring intermediate neutron spectra by a time-of-flight method using a pulsed point source of fast neutrons and a counter sensitive only during a certain period. It is shown that the proposed experiment is feasible only for fairly light moderators. The transport equation is solved by the polynomial approximations method introduced by Spencer and Fano. A.

539.185.08 : 537.542

A fission counter with high fissile material density for fast neutron fission counting. *See Abstr.* 9721

STRUCTURE OF SOLIDS 539.2

539.213 : 537.531 : 535.343

9980. On the fine structures of X-ray absorption spectra of amorphous substances. The amorphous state of the binary system of nickel–sulfur. II. M. SAWADA, K. TSUTSUMI, T. SHIRAIWA AND M. OBASHI. *J. Phys. Soc. Japan*, **10**, *No.* 6, 464–8 (*June*, 1955).

For previous part, see Abstr. 7407 (1955). The fine structures of Ni *K* X-ray absorption spectra in the amorphous and crystalline states were photographed, using the samples described in Pt I. The wavelengths of the fine structures of the Ni *K*-absorption edge and intensities of their non-absorption maxima were measured. The fine structures in the amorphous states show, in their shapes and wavelengths, a similarity to those shown by the substances which have undergone crystallization. But generally in the amorphous state the fine structure is less pronounced at the shorter wavelength side than in the crystalline state. Amorphous Ni–S is concluded to be an aggregate state of fine crystals, and crystal size is thought to influence the region of the extended fine structure. A.

539.217

9981. On the diffusion of electrically charged lattice defects of different mobilities. B. ILSCHNER. *Z. Elektrochem.*, **59**, *No.* 6, 542–4 (1955) In German.

The motion of positive and negative defects of different mobility in concentration gradients and electric fields is discussed. The space charges associated with concentrations of defects limit the extent of the boundary layer where there are high fields to about a micron for 10^{15} carriers/cm^3, or to 100 Å for 10^{20}/cm^3. The results are applied to oxidation reactions where ambipolar diffusion is important. W. M. LOMER

539.217

9982. On the theory of the Kirkendall effect. F. SEITZ. *J. Phys. Soc. Japan*, **10**, *No.* 8, 679–85 (*Aug.*, 1955).

The problem of determining the nature of the lattice defects which are responsible for transport of atoms in metals is discussed. The value of the Kirkendall effect in deciding that most of the transport is associated with migrating vacancies or interstitial atoms is restated. It is emphasized that there does not yet exist a satisfactory experimental method for deciding which of the two types of imperfection is most important in typical metals. A.

539.217

9983. Self-diffusion in lead. N. H. NACHTRIEB AND G. S. HANDLER. *J. chem. Phys.*, **23**, *No.* 9, 1569–70 (*Sept.*, 1955).

The rate of self-diffusion in single crystals of high purity lead has been measured over the temperature range 174° to 322°C by means of RaD. The data are fitted by the least squares equation $D = 0{\cdot}281 \times \exp[-24\,210/RT]\,\mathrm{cm^2\,sec^{-1}}$. A.

539.217 : 539.16.08

9984. Studies on diffusion. I. Diffusion of radioactive matter through plates. U. ASWATHANARAYANA AND S. RAMAMURTHY. *Proc. Indian Acad. Sci. A*, **42**, *No.* 2, 71–6 (*Aug.*, 1955).

As a part of an attempt to develop new methods of measurement of diffusion constant of metals and non-metals into minerals using radioactivity techniques, expressions are derived to relate the processes of diffusion and the emission of α-particles under three sets of possible experimental conditions. The first case pertains to a plate whose thickness is equal to the characteristic range of the α-rays of the radionuclide used. Under the second case is considered a plate thicker than the characteristic range of the α-rays in the plate. The third deals with cases wherein the radioactive matter used emits α-rays with different ranges less than the thickness of the plate. A.

539.217 : 539.164 : 778.34

9985. The use of nuclear plates for the measurement of the diffusivity of an alpha ray active element into a solid. J. H. J. POOLE AND J. N. T. WHITE. *Sci. Proc. Roy. Dublin Soc.*, **27**, *No.* 1, 1–15 (*July* 20, 1955).

The theory of a nuclear plate method of measuring the diffusivity of an α-ray active tracer into a solid is developed. Some results for the diffusivity of polonium at various temperatures into nickel and lead are given, and the statistical errors inherent in the method discussed. It is suggested that the observed increase in the diffusivity with the depth of the layer of the metal considered may be due to the occurrence of grain boundary diffusion as well as lattice diffusion. The method is capable of measuring very small diffusivities; thus it is found that the diffusivity of polonium into nickel at air temperatures is of the order of 10^{-13} cm^2 per day. A.

539.217 : 548

9986. Self-diffusion and ionic conduction in crystals. E. KATZ. Letter in *Phys. Rev.*, **99**, *No.* 4, 1334 (*Aug.* 15, 1955).

Points to a probable explanation of the deviation of the Einstein relation, where $\sigma/D > Ne^2/kT$; this deviation was found in a recent unpublished research. The explanation is based on a correction to be applied to the customary derivations of the Einstein relation in the case of dielectrics. F. LACHMAN

539.219

9987. Internal friction peak associated with precipitation in an Al — Ag alloy. A. C. DAMASK AND A. S. NOWICK. *J. appl. Phys.*, **26**, *No.* 9, 1165–73 (*Sept.*, 1955).

Internal friction and elastic after-effect measurements have been made on wire specimens of an Al — 20% Ag alloy at various stages in the precipitation process. A specimen quenched from the solid solution region and aged at 155°C shows an internal friction peak at 140°C for a vibration frequency of 0·25 c/s. The relaxation strength associated with the peak is about 0·02. The peak is not greatly affected by further anneals although these anneals completely change the character of the precipitate from the initial spherical clusters of solute atoms to the plate-like transition (γ') precipitate. In the temperature range in which clusters redissolve (reversion), however, the internal friction shows a temperature hysteresis. The activation energy associated with the internal friction peak falls in the range 25–27 kcal/mole, depending on the state of precipitation. A mechanism is suggested whereby the peak originates in a stress-induced change in the local extent of precipitation. This behaviour results from the interaction of the applied stress with the internal stresses about precipitate particles. In terms of this mechanism one can account qualitatively for the principal experimental observations. A.

539.219 : 536.631

9988. Specific-heat versus temperature curves of aged Cu–Be alloys. K. HIRANO. Note in *J. Phys. Soc. Japan*, **10**, *No.* 8, 721–2 (*Aug.*, 1955).

Specific heats were measured at heating rates of 2 deg/min in specimens of Cu 1·8% Be which were solution-treated at 800°C, and quenched and subsequently aged at temperatures between 130 and 400°C. A heat absorption is seen in all alloys above 450°C, corresponding to resolution of the precipitate. An absorption at 200°C in specimens aged at 130°C may correspond to dispersal of Preston–Guinier zones. W. M. LOMER

539.26

9989. X-ray studies of optical coatings. F. W. PAUL. Letter in *J. Opt. Soc. Amer.*, **45**, *No.* 9, 773–4 (*Sept.*, 1955).

Discusses, with examples, the application of X-ray diffraction and fluorescence X-ray analysis to the examination of optical coatings. J. THEWLIS

539.27

9990. Theory and practice of electron microscope stereo photographs. III. Methods for relief measurements on electron-microscopic objects and development of a quantitative photogrammetric apparatus. J.-G. HELMCKE. *Optik*, **12**, *No.* 6, 253–73 (1955) In German.

This paper is a continuation of a previous paper [Abstr. 8337 (1954)] and deals principally with the experimental technique for obtaining accurate and quantitative results from stereophotographs taken in the electron microscope. The author describes a stereo measuring apparatus called "Elmigraph I" which has been developed following the principles laid down in this series of papers.

A.E.I. RESEARCH LABORATORY

539.27

9991. The Elmigraph I, a new apparatus for measuring and mapping electron microscope photograph pairs in space. R. BURKHARDT. *Optik*, **12**, *No.* 9, 417–29 (1955) In German.

Electron microscope stereo-pairs do not lend themselves to measurement on mapping systems such as are used for air photographs, since these relate only to centred perspective. The apparatus here described uses auxiliary mirrors to produce an optical model of the original object, and the model is then measured by a separately controlled measuring mark. The various adjustments, carried out by hand and foot controls, can be made independently, and the original object can, without intermediate calculations, be mapped either as contours on a grid, or in "military perspective" [*sic*]. A.E.I. RESEARCH LABORATORY

ELASTICITY . STRENGTH . RHEOLOGY
539.3/.8

539.31 : 538.221

A magnetic internal friction peak in nickel under alternating magnetic field. *See Abstr.* 9771

539.31 : 548.7

9992. On the theory of the elasticity of crystals. C. V. RAMAN AND K. S. VISWANATHAN. *Proc. Indian Acad. Sci. A*, **42**, *No.* 2, 51–70 (*Aug.*, 1955).

The fundamental aspects of the phenomenological theory of elasticity are critically examined and it is shown that the tensor representation of the elastic strains and stresses in the general case should be in the unsymmetrical form. On this basis, the stress-strain relationships are deduced and tabulated for the different crystal classes. The equations determining the velocities of wave-propagation in different directions are also obtained and tabulated. Static deformation problems are then discussed and it is shown that in the particular case of homogeneous strains, the elastic constants group themselves in linear combinations which are equivalent to the elastic moduli of the theory in its familiar form. In wave-propagation, however, the strains and stresses are heterogeneous and hence all the elastic constants are involved and appear in linear combinations which are different and also larger in number than those which figure in the formulae for homogeneous deformations. These results are completely in accord with the consequences of the atomistic theory based on interatomic forces of the most general type. A.

539.313

9993. Large elastic deformations of isotropic materials. X. Reinforcement by inextensible cords. J. E. ADKINS AND R. S. RIVLIN. *Phil. Trans A*, **248**, *No.* 944, 201–23 (1955).

For Pt IX, see Abstr. 4147 (1952). The theory of large elastic deformations of incompressible, isotropic materials is employed to examine some simple deformations of elastic bodies reinforced with cords. The cords are assumed to be thin, flexible and inextensible, and to lie parallel and close together in smooth surfaces in the undeformed body, which is

thus divided into sections by boundary surfaces which are inextensible in certain directions. In the simple problems considered, the cords impose relationships upon the parameters which specify the deformation. The following examples are examined from this point of view: (i) the pure homogeneous strain of a thin uniform sheet containing a double layer of cords lying in a plane midway between its major surfaces; (ii) the combined pure homogeneous strain and flexure of a cuboid containing a double layer of cords lying in a plane parallel to a pair of opposite faces, the two sets of cords being unsymmetrically disposed in this plane with respect to the remaining faces of the cuboid, and the symmetrical case being obtained from this by a suitable choice of constants; (iii) the combined extension and flexure of a thin rectangular sheet with two sets of cords placed symmetrically in a plane parallel to its major surfaces, the problem being considered as a limiting case of (ii); (iv) the simultaneous extension, inflation and torsion of a cylindrical tube containing one or two sets of cords lying in helical paths concentric with the axis of the cylinder. In all cases, relations are obtained for the determination of the tensions in the cords in terms of the applied forces and the parameters which define the deformation. A.

539.32

9994. Young's modulus of crystalline, unstretched rubber. M. LEITNER. *Trans Faraday Soc.*, **51**, *Pt* 7, 1015–21 (*July*, 1955).

A specimen of raw, unstretched rubber was allowed to crystallize at 0°C. Measurements of the density and of Young's modulus were taken at intervals while crystallization was in progress. When crystallization had effectively ceased, step-wire melting was achieved by gradual warming and measurements were made on the partially melted specimen. Thus, the correlation between the degree of crystallinity of the material and its Young's modulus was established. There appears to be no obvious interpretation of the observed hundred-fold increase in modulus at present. A.

539.32

9995. Measurement of the elasticity of solid argon with an ultrasonic interferometer. J. R. BARKER AND E. R. DOBBS. *Phil. Mag.*, **46**, 1069–80 (*Oct.*, 1955).

The adiabatic compressibility and adiabatic Poisson's ratio for solid argon have been measured by determining the velocities of longitudinal and transverse ultrasonic waves in fine-grained polycrystalline specimens between 65° and 80°K. The cryostat, the ultrasonic interferometer and the preparation of the specimens are described. The compressibility is estimated to rise from 0·42 to $0{\cdot}62\times10^{-10}$ cm²/dyn between 0°K and the melting-point; Poisson's ratio is 0·30. Existing data are used to estimate the expansivity at various temperatures. The compressibilities are compared with other measurements and with various theoretical estimates. The results are consistent with a Gruneisen parameter $\gamma = \alpha V/\kappa_s C_p = 1{\cdot}2$. A.

539.32 : 532.696.1

9996. An experimental study on the change in Young's modulus of quenched carbon steel due to wetting by liquids. M. SATO. *J. Sci. Res. Inst.* [*Tokyo*] **49**, 1–3 (*March*, 1955).

The change in Young's modulus of a quenched carbon steel due to wetting by several liquids is studied experimentally, showing that the modulus is lowered by one group of liquids, while the reverse is the case with another group. A.

539.32 : 534.21

9997. Elastic constants of zircon. J. BHIMASENACHAR AND G. VENKATARATNAM. *J. Acoust. Soc. Amer.*, **27**, *No.* 5, 922–6 (*Sept.*, 1955).

The elastic constants of a single crystal of zircon have been determined using the ultrasonic wedge method. The values of the constants are (units of 10^{11} dynes/cm²) $c_{11} = 7{\cdot}35$, $c_{33} = 4{\cdot}60$, $c_{44} = 1{\cdot}38$, $c_{66} = 1{\cdot}60$, $c_{12} = 0{\cdot}90$ and $c_{13} = -0{\cdot}54$. The value of compressibility $\beta = 47{\cdot}6\times10^{-13}$ cm²/dyne. A.

539.371

9998. Some notes on the relation between the elastic moduli of anisotropic crystallites and quasi-isotropic polycrystalline aggregates. H. H. STADELMAIER. *Z. angew. Math. Phys.*, **6**, *No.* 3, 247–52 (1955).

The assumption that the elastic constants of a polycrystalline aggregate can be derived by a suitable average of single crystal values is shown to depend on the assumption that deformation in each crystallite is homogeneous, coherence between crystallites being maintained by a severe deformation in a vanishingly thin boundary layer. This should always lead to an average modulus which is too low. The different mathematical approximations to the correct average (stress everywhere constant, strain everywhere constant, or Huber and Schmidt's method) superpose other errors which compensate for the original limitations only in the last case. W. M. LOMER

539.371

9999. The elastic behaviour of isotropic solids. C. V. RAMAN AND K. S. VISWANATHAN. *Proc. Indian Acad. Sci. A*, **42**, *No.* 1, 1–9 (*July*, 1955).

The notions regarding stresses and strains adopted in the classical theory of elasticity are critically examined. The neglect of rotations in the analysis of strain and of torques in the analysis of stress characteristic of that theory is shown to be unjustifiable. A reformulation of the stress-strain relationships taking account of these factors leads to the result that an isotropic solid has *three* independent elastic constants and not *two* as hitherto supposed. Two of these three constants determine the velocities of propagation respectively of longitudinal and transverse waves in the solid. The latter does not make its appearance in any observations involving only homogeneous strains nor does it appear in the formulae for the bulk modulus, Young's modulus and Poisson's ratio obtained in the present paper. A.

539.371 : 539.374 : 539.217

10000. The elasto–plastic hollow body problem. W. DREYER. Note in *Naturwissenschaften*, **42**, *No.* 13, 386–7 (1955) In German.

Equations are set up for the deformation of a porous body taking account of both elastic and plastic contributions, using a parabolic work-hardening law. It is found that the compressibility of rock salt is increased by 1% porosity from

$2{\cdot}5\times10^{-5}$cm²/kp to 4×10^{-5}cm²/kp. The stress distribution is discussed; the effect of a pore, in uniaxial compression, extends only a few pore diameters. W. M. LOMER

539.373

10001. Surface phenomena on extended aluminium single crystals and their dependence on the velocity of extension. H. MÜLLER AND G. LEIBFRIED. *Z. Phys.*, **142**, *No.* 2, 87–115 (1955) In German.

Single crystals of Al of controlled orientation were extended at room temperature at strain rates from 10^{-6} to over 10^{2}, and the slip line structure examined by optical and electron microscopy. The slip line density increased to double as the strain rate was raised between these limits. The breadth of the lines decreases rapidly up to 10^{-3}/sec, then more slowly. The length of the slip lines decreases slowly up to a strain rate of 10^{2}/sec and then rapidly. Investigation of clustering showed that the most common spacing was always about $1{\cdot}5\,\mu$, which may be regarded as the range of the stress field of a work-hardened plane. The density of striations and kink bands increases with velocity. At liquid-air temperature the glide bands are shorter, denser and narrower, and kink bands are ten times more dense. The results are discussed in terms of a theoretical model of the state of the interior of the crystal, and it is deduced that at high strain rates dislocations move at a speed of at least 20 metres/sec. W. M. LOMER

539.373

10002. Origin of Guinier–Preston zones in alloys. K. HIRANO, Y. TAKAGI AND H. MANIVA. Note in *J. Phys. Soc. Japan*, **10**, *No.* 7, 587–8 (*July*, 1955).

The formation of Preston–Guinier zones is not a pre-precipitation phenomenon since it can occur in unsaturated alloys. Two possible mechanisms of formation are presented; vacancy condensation into ring dislocations produces a stress-field which may be relieved by diffusing in solute atoms of a different size, or a stacking fault may favour a high concentration as in the Suzuki dislocation locking mechanism. W. M. LOMER

539.373

10003. Free slip in monocrystals. B. JAOUL. *C.R. Acad. Sci.* [*Paris*] **241**, *No.* 2, 161–3 (*July* 11, 1955) In French.

The first part of the stress-strain curve representing plastic flow of a single crystal, from the initial yield to the point of inflection, is observed to be of the form (stress increment) $\propto$ log (strain increment). A theoretical justification of this equation is given, based on the increasing density of obstacles to flow, arising where slip planes intersect. [B. Jaoul, *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 26, 2532 (*June* 27, 1955).] J. G. OLDROYD

539.373

10004. The velocity of dislocations. J. S. KOEHLER. *J. Phys. Soc. Japan*, **10**, *No.* 8, 669–72 (*Aug.*, 1955).

The theory of Mott and of Fisher, Hart and Pry for the production of slip bands is considered. This theory suggests that the kinetic energy of dislocations is what keeps glide on a slip band going; it also asserts that the process is stopped by the back stress resulting from dislocation loops previously generated at the Frank–Read source. Experimental observations giving the damping experienced by a dislocation and giving the velocity of glide are used to show that the potential energy of a dislocation is in general more than a hundred times the kinetic energy. Present evidence indicates that the rate of glide decreases by a factor of about fifty during the production of a single slip band in aluminium. Present data also indicates that twinning requires rapid dislocations whereas slip seems to demand slow dislocations. A way of reconciling these observations is suggested. A.

539.374

10005. On the plasticity of silver bromide. H. KANZAKI. *J. Phys. Soc. Japan*, **10**, *No.* 8, 663–8 (*Aug.*, 1955).

Experimental study on the plastic deformation and the recovery process from strain hardening is described on single crystals of silver bromide. The various sorts of defects created during deformation are separated in each stage of recovery process, because of the difference of mobility energies. The difference of the mobility energies is also revealed in the change of the temperature dependence of excess ionic conductivity during the recovery process. From the measurements of the change of excess ionic conductivity and the release of energy in the recovery process, the number of defects produced by deformation at room temperature was determined to be 10^{-1} per atom of anti-Schottky defects and 10^{-4} per atom of Schottky defects. The mechanism of recovery from hardening, and the lifetime of defects in recovery from strain hardening and from thermal quenching are discussed. A.

539.374

10006. Isothermal viscosity–molecular weight dependence for long polymer chains. T. G. FOX AND S. LOSHAEK. *J. appl. Phys.*, **26**, *No.* 9, 1080–3 (*Sept.*, 1955).

Evidence is given showing that the equation, $\log\eta = 3{\cdot}4\log Z + K$, represents an empirical law of flow which holds generally for sufficiently long flexible chain molecules in bulk or in solution. Here η is the viscosity, Z is the number of atoms in the chain, and K is a constant which is dependent on the polymer type and on the temperature. All of the available data which cover wide molecular weight ranges for linear (and branched) molecules in bulk or in solution, including results on polyesters, polyamides, polystyrene, polyisobutylene, polydimethyl siloxane and polymethyl methacrylate, support this conclusion. For chains having fewer than a critical number, Z_c, of chain atoms (Z_c being characteristic of the polymer species) the dependence of η on Z is less severe but more complex. These results are in semiquantitative agreement with the recent theory of F. Bueche. On the basis of this theory, values for the concentration of chain entanglements in various polymers are obtained from the observed values of Z_c. A.

539.374

10007. Plastic flow in coal. P. C. NEWMAN. *Brit. J. appl. Phys.*, **6**, *No.* 10, 348–50 (*Oct.*, 1955).

During briquetting of coal, conditions favourable to plastic flow may be developed by the non-uniform

stress system. Photographs of particles of coal removed intact from both rock salt and coal briquettes show that plastic flow has occurred at moderate briquetting pressures. A.

539.374

10008. The release of energy during annealing of deformed metals. L. M. CLAREBROUGH, M. E. HARGREAVES AND G. W. WEST. *Proc. Roy. Soc. A*, **232**, 252–70 (*Oct.* 25, 1955).

The method described for measuring the energy stored in cold-worked metals [Abstr. 2767 (1953)] has now been applied to nickel and arsenical copper as well as to pure copper. Torsion, tension and compression have been used as methods of deformation, and the heating rates were 2, 4 and 6 deg C/min. For all these materials, for all types of deformation and for all heating rates a sudden release of energy corresponding to recrystallization is observed and this comprises the total stored energy for pure copper. Thus, for pure copper, there is no indication of the two stages in the release of the stored energy reported by Suzuki. However, for nickel and arsenical copper a considerable proportion of the stored energy is released prior to recrystallization. Measurements of electrical resistivity, hardness and macroscopic density have been made on similar specimens, and correlation of these results with the measurements of stored energy suggests that the release of energy prior to recrystallization, in nickel and arsenical copper, should be ascribed to the rearrangement and annihilation of dislocations and also, in nickel, to the disappearance of vacancies produced during deformation. Values are given for the energy stored in specimens deformed to various extents in torsion, tension and compression at room temperature, and it is shown that the energy released on recrystallization is a linear function of the strain. Estimates of the density of dislocations corresponding to this energy are made for various strains. The disappearance of vacancies in nickel releases an amount of energy which is almost independent of the strain, for the comparatively large strains investigated and the density measurements indicate that this energy corresponds to 1·6 eV per vacancy. A.

539.374 : 539.63

10009. Extension of the Hertz theory of impact to the viscoelastic case. Y.-H. PAO. *J. appl. Phys.*, **26**, *No.* 9, 1083–8 (*Sept.*, 1955).

The problem considered is that of two bodies coming into normal contact over smooth curved surfaces. The initial relative velocity and the total kinetic energy involved is low. Contact is, however, confined to such small volumes of the objects involved that very high concentrations of energies are obtained at those places. The rates of application of stress are correspondingly high. The Hertz solution to this type of problem provides a useful approximation in the case of elastic objects. In the present treatment one of the impinging bodies is of viscoelastic material. Two viscoelastic bodies may also be treated if they are of the same material. The Laplace transform method is used to obtain the viscoelastic expression for the force developed between the two surfaces. This expression is then applied to the impact case. The expression can also be applied to other truly static cases; e.g. contact between gear tooth surfaces. The results are of technological interest, since it is not possible to say if a plastic is suitable for a certain category of impact applications, unless the rates of straining or stressing obtained in those applications can be estimated. A.

539.374 : 541.64

10010. On the viscoelastic properties of polymethyl methacrylate. S. IWAYANAGI. *J. Sci. Res. Inst.* [*Tokyo*] **49**, 4–12 (*March*, 1955).

Torsional creep measurements on PMMA (polymethyl methacrylate) were carried out at high temperatures (up to 140°C) with results supporting the concept of "semipermanent network structure." An apparatus was designed to observe the torsional stress relaxation by twisting a cylindrical polymer specimen suspended by a thin steel rod. Relaxation curves obtained with PMMA in the temperature range from −40 to 130°C fall into low- and high-temperature groups. Supposing the polymer is "thermorheologically simple" within each of these ranges of temperature, master relaxation and creep curves are constructed, and the temperature functions $\kappa(T)$'s, and therefrom the activation energies are determined separately. These results are compared with those for tensile stress relaxation by Tobolsky. All the viscoelastic data on PMMA, both transient and vibrational as well as dielectric, obtained by various authors up to the present are summarized in a "transition map" and compared with one another. A.

539.374 : 541.64

10011. Dynamical measurements on the viscoelasticity of polymethyl acrylate. S. IWAYANAGI. *J. Sci. Res. Inst.* [*Tokyo*] **49**, 13–22 (*March*, 1955).

The temperature-dependence of complex shear modulus of PMA (polymethyl acrylate) is studied by three measuring methods employing (1) pendulums of frequency 0·5 c/s, (2) a twin transducer (from 100 to 400 c/s) and (3) a tuning fork of natural frequency 1 000 c/s. The activation energy for viscoelastic deformation of PMA is determined as ∼75 kcal/mol different from the value of ∼60 kcal/mol found for dielectric orientation. Contary to the case of polymethyl methacrylate, the secondary anomalous absorption region cannot be observed separately from the primary. It is also suggested that PMA is far from being "thermorheologically simple" in the sense meant by Schwarzl and Staverman. A.

539.374 : 541.64

10012. On the viscoelastic properties of linear amorphous polymers in relation to their molecular structure (polymethyl methacrylate and acrylate). S. IWAYANAGI. *J. Sci. Res. Inst.* [*Tokyo*] **49**, 23–34 (*March*, 1955).

The experimental facts, both viscoelastic and dielectric, concerning the existence of a secondary anomalous absorption region beside the primary one in the case of polymethyl methacrylate and the interblending of these two regions in the case of polymethyl acrylate, are summarized and reviewed. The nature of secondary anomalous absorption is clarified to some extent in terms of the orientation of polar ester groups of these polymers and of the steric hinderance due to methyl groups of polymethyl methacrylate. At the same time the validity of the

assumption that a polymer is "thermorheologically simple" in the sense meant by Schwarzl and Staverman is discussed, using semi-empirical reaction-rate theory with particular reference to the polar nature of the polymer. A.

539.374 : 541.64

10013. Theory of viscoelasticity of amorphous polymers. O. NAKADA. *J. Phys. Soc. Japan*, **10**, *No.* 9, 804–13 (*Sept.*, 1955).

A statistical mechanical theory of the intra-chain relaxation (or relaxation of the micro-Brownian motion) in amorphous polymers is presented. The generalized diffusion equation of configurational changes of a chain imbedded in polymer environment is solved for a dynamical case under suitable potentials assumed. In order to avoid the complication of the chain space geometry, an artifice is adopted such that each chain bond is replaced by a fictitious spring. The derived spectrum of relaxation times just coincides with the experimental formula of the wedge-type spectrum found by Tobolsky for polyisobutylene, manifesting a characteristic slope of $-1/2$ in the log-log plot of the relaxation spectrum. The theoretical expression also satisfies the condition of the thermorheological simplicity. A.

539.379

10014. Retraction of oriented polystyrene monofilaments. R. D. ANDREWS. *J. appl. Phys.*, **26**, *No.* 9, 1061–8 (*Sept.*, 1955).

When oriented polystyrene monofilaments are heated to temperatures in the neighbourhood of the transition temperature they retract to an unoriented state at conveniently measurable rates. Curves of length as a function of time have been measured at five different temperatures (75–95°C, at 5 deg intervals) for two filaments with different initial amounts of orientation. When the retraction curves are plotted as length $v.$ log time, it is found that the curves at different temperatures are not superposable by lateral shift along the logarithmic time scale, as would be true for simple viscoelastic behaviour. Activation energies calculated from these curves are a function of time as well as of temperature; the activation energy at any given temperature tends to level out to a final constant value with increasing time, however. The rate of change of activation energy with time increases with increasing temperature, so that the final value is attained more quickly; the final value also decreases systematically with increasing temperature. Final activation energy values increase rapidly with decreasing temperature in this region and are very high (300 kcal at 75°). It is postulated that specific volume changes are responsible for the time-dependent activation energies observed in these experiments. It is also of interest that these experiments appear to isolate the viscoelastic mechanism involving molecular configuration change from that involving local molecular distortions. A.

539.379

10015. X-ray diffraction studies of crystallization in elastomers. L. E. ALEXANDER, S. OHLBERG AND G. R. TAYLOR. *J. appl. Phys.*, **26**, *No.* 9, 1068–75 (*Sept.*, 1955).

In general, extension of an elastomer results in a degree of preferred orientation of the molecular chains composing the amorphous phase. Therefore the amorphous fraction of a partially crystalline elastomer must be related to the integrated intensity of the amorphous diffraction halo rather than to the intensity at any one azimuth. A noteworthy exception is natural rubber, for which simple meridional measurements suffice. A Geiger-counter apparatus with beam monitor and temperature-controlling accessories is described for making accurate measurements of the X-ray intensities scattered at any azimuth and at small or moderate Bragg angles. Measurements of crystallinity in natural rubber are in essential agreement with the findings of previous workers. When polybutadiene is extended at room temperature, molecular orientation occurs, but little if any crystallization. Measurements at lowered temperatures show that the crystalline fraction becomes appreciable at about 0°C and that it increases with further reduction in temperature and with increasing extension ratio. Preferred orientation of the crystalline regions in extended polybutadiene has been measured quantitatively with the object of providing jointly with birefringence measurements a value of the birefringence of a single crystal of polybutadiene. A.

539.379

10016. Birefringence and crystallization in elastomers. G. R. TAYLOR AND S. R. DARIN. *J. appl. Phys.*, **26**, *No.* 9, 1075–80 (*Sept.*, 1955).

The semi-theoretical expression, $f_c = (\Delta n_0 - cs)/(F\Delta n_c^0 - cs)$, where f_c = volume fraction crystalline, Δn_0 = observed birefringence, c = the stress-optical coefficient, s = the stress on actual cross-section, F = a known function of crystallite orientation and Δn_c^0 = the birefringence of a single polymer crystal, is proposed for relating birefringence, stress and degree of crystallinity in polycrystalline elastomers under tensile stress. This expression is shown to yield results in substantial agreement with X-ray results for the degree of crystallinity of 5°C polybutadiene when $\Delta n_c^0 = 0{\cdot}157$. Birefringence-density data on natural rubber (due to L. R. G. Treloar) are shown to be a special case of the foregoing expression, yielding a value $\Delta n_c^0 = 0{\cdot}218$ for natural rubber which is in good agreement with the theoretical value for this quantity. A.

539.379

10017. Glass transitions in polymer–plasticizer systems. L. BREITMAN. *J. appl. Phys.*, **26**, *No.* 9, 1092–9 (*Sept.*, 1955).

Glass temperatures (T_g) of pure and plasticized elastomers have been obtained from dilatometric measurements and from the temperature dependence of angular response to torsional stress. The depression of T_g by a diluent, determined by either method, is a convenient measure of its plasticizing ability. Some compounds which are normally crystalline above T_g of the pure polymer, but nevertheless compatible with the polymer, depressed the glass temperature. The polymer-diluent compatibility at low temperatures results either from supercooling, the depression of the melting-point of diluent by polymer, or possibly a combination of both phenomena. T_g decreased as the diluent loading increased to a more or less well defined limit, beyond which further dilution had negligible effect. For diester type

plasticizers both $\Delta T_{g\max}$ and the limiting diluent concentration were linear functions of compatibility, as defined by the extent to which standard polymer vulcanizates were swollen by plasticizer. The viscosities and apparent activation energies for flow (E_v) of hydrocarbon oils correlated with their low temperature plasticizing efficiencies. Pour points and glass temperatures may also be significant properties of the diluents. It is concluded that low E_v and high solvency for polymer are desirable properties for low-temperature plasticizers. A.

539.383

10018. Unilateral compression of rubber. M. J. Forster. *J. appl. Phys.*, **26**, *No.* 9, 1104–6 (*Sept.*, 1955).

One-dimensional compression measurements have been made on samples of natural rubber gum stock. The experimental stress–strain curve and the theoretical relation $f = G(L - 1/L^2)$ agreed well over the entire range (0–32%) studied. No hysteresis loop was evident. The friction at the faces of the sample was eliminated by a new method of lubrication. The sample essentially floated between two thin films of a liquid which flowed under pressure between the sample and compressing plates allowing uniform expansion of the sample. A.

539.383 : 535.551

Apparatus for making simultaneous stress and birefringence measurements on polymers. *See Abstr.* 9594

539.389.3 : 541.64

10019. The temperature dependence of relaxation mechanisms in amorphous polymers and other glass-forming liquids. M. L. Williams, R. F. Landel and J. D. Ferry. *J. Amer. Chem. Soc.*, **77**, *No.* 14, 3701–7 (*July* 20, 1955).

The ratio a_T of all mechanical and electrical relaxation times at temperature T to their values at a reference temperature T_s can be expressed, after suitable choice of T_s, by the equation $\log a_T = -8{\cdot}86\ (T - T_s)/(101{\cdot}6 + T - T_s)$. Over a T range of $T_s \pm 50$ deg, this applies to a wide variety of polymers, polymer solutions, organic glass-forming liquids and inorganic glasses. As chosen, T_s lies about 50 deg. above the glass transition temperature T_g. If, alternatively, the reference temperature is chosen as T_g, then $\log a_T \simeq -17{\cdot}44(T - T_g)/(51{\cdot}6 + T - T_g)$. Above $T_s + 50$ (or $T_g + 100$) the equation fails because different systems show specific properties which are no longer dominated by the non-specific behaviour associated with supercooling and vitrification. The apparent activation energy for relaxation processes, unlike a_T, is not a universal function of $T - T_s$ or $T - T_g$. The empirical equations are shown to be consistent with earlier formulations of Fox and Flory, Tobolsky, Dienes and Bueche over limited temperature ranges. Comparison with a simplified version of Doolittle's free space equation for temperature dependence of viscosity shows that the empirical constants are determined by the increase in thermal expansion coefficient at the glass transition temperature and the fractional free volume at that point. The latter quantities are calculated to be $4{\cdot}8 \times 10^{-4}\,\mathrm{deg}^{-1}$, in rather good agreement with experimental measurements, and 0·025, a reasonable value. A.

539.4.016.2

10020. The migration of solute atoms to dislocation arrays. B. A. Bilby. *J. Phys. Soc. Japan*, **10**, *No.* 8, 673–9 (*Aug.*, 1955).

The dislocation theory of strain ageing, as previously given for an isolated dislocation, is applied to the ageing of the dislocation array representing a small angle tilt boundary, and a change in the time law of ageing is predicted. The ageing of the array, and of isolated dislocations, is also considered using a model which allows for diffusion, and for competition for the solute atoms between arrays, or between isolated dislocations. The results are compared with available data for the initial stages of ageing and further experiments are suggested. A.

539.431

10021. A theory of fracture and fatigue. N. F. Mott. *J. Phys. Soc. Japan*, **10**, *No.* 8, 650–6 (*Aug.*, 1955).

The concept of a piled-up group of dislocations is discussed, and its relation to ductile fracture, to brittle fracture and to fatigue. It is suggested that a large enough stress induces fracture at a piled-up group, and a large number of such small cracks can join together to produce a ductile or fatigue fracture. A.

539.67

10022. Apparatus for the measurement of the internal friction of metals in transverse vibration. B. S. Berry. *Rev. sci. Instrum.*, **26**, *No.* 9, 884–7 (*Sept.*, 1955).

Apparatus incorporating a specially designed piezoelectric pickup serving in turn as an exciter and detector is described for the measurement of the internal friction of vertically suspended specimens vibrating transversely *in vacuo* in the free–free mode. Measurements have been made by the free-decay method in the frequency range 5 c/s–2 kc/s, and at maximum strain-amplitudes of $10^{-4} - 5 \times 10^{-7}$. The method of frequency variation by loading with weights has been applied successfully to the fundamental vibration. Methods of investigating external energy losses are described, and results presented to show that the total external loss is small, rarely exceeding 5% of the observed internal friction. A.

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.113 : 536.631

10023. The atomic heat of sodium. D. H. Parkinson and J. E. Quarrington. Letter in *Proc. Phys. Soc. A*, **68**, *Pt* 8, 762–3 (*Aug.*, 1955).

Reports results of measurements between 1·4 and 20°K. The specific heat, temperature curve is monotonic over this range. The linear electronic

heat coefficient is deduced to equal $4{\cdot}3\times 10^{-4}$ cal.mol^{-1}.deg.$^{-2}$, about 60% above the Sommerfeld value. The Debye temperature equals 158°K up to 3°K, then drops to a minimum of 147°K at 6°K and finally rises again, reaching 155°K at 20°K.

E. P. WOHLFARTH

541.123.2

10024. Kinetics of the isotope exchange reaction of fluorine with hydrogen fluoride. R. M. ADAMS, R. B. BERNSTEIN AND J. J. KATZ. *J. chem. Phys.*, **23**, *No.* 9, 1622–5 (*Sept.*, 1955).

The exchange of radioactive F^{18} between hydrogen fluoride and fluorine has been studied over a wide range of concentrations at three temperatures in the range 194° to 257°C. The exchange may be accounted for entirely by a heterogeneous catalysis mechanism involving competitive adsorption of the Langmuir–Hinshelwood type. Experiments have been performed indicating the important role of surface treatment on the kinetics of the exchange. A.

541.123.2 : 539.155.2

10025. γ-Ray-induced deuterium gas–water exchange. S. GORDON AND E. J. HART. *J. Amer. Chem. Soc.*, **77**, *No.* 15, 3981–4 (*Aug.* 5, 1955).

Deuterium gas dissolved in light water has been found to undergo exchange with the H of the water when these solutions are exposed to the γ-radiation of Co^{60}. In neutral and acid solutions the major product of the exchange is hydrogen deuteride. Hydrogen is also formed in smaller yields. In alkaline solutions the hydrogen deuteride formation is suppressed whereas the hydrogen formation is unchanged over a wide range of pH's. The effects of pH, deuterium concentration and dose rate have been determined, and a mechanism is postulated. A.

541.124

10026. Mechanism of oxidation of cuprous oxide at high temperatures. K. HAUFFE AND P. KOFSTAD. *Z. Elektrochem.*, **59**, *No.* 5, 401–6 (1955) In German.

The oxidation was studied by a streaming method. Between 800° and 1 000°C the law $w = kt^{1/3}$ was obeyed for a number of different oxygen pressures (w = extent of oxidation in time t), the constant k being almost independent of temperature above 800°C. At lower temperatures the cubic law was followed only after an initial period during which a parabolic law held. All specimens had been pretreated with 0_2 at pressure p at 1 000°C and then outgassed at 1 000°C, and k increased linearly with log p. The results are interpreted in terms of the edge-layer theory [Abstr. 532 (1950)]. S. J. GREGG

541.124

10027. Modified bond-eigenfunction method of calculating potential energy surfaces and its application to the reaction $H + H_2 \rightarrow H_2 + H$. I. YASUMORI. Letter in *J. chem. Phys.*, **23**, *No.* 8, 1566 (*Aug.*, 1955).

The method, an outline of which is given, leads to activation energy values which show much improvement on those of previous work. W. GOOD

541.124

10028. Thermal decomposition of nitric oxide. F. KAUFMAN AND J. R. KELSO. *J. chem. Phys.*, **23**, *No.* 9, 1702–7 (*Sept.*, 1955).

The decomposition of pure nitric oxide and of mixtures with nitrogen or helium was studied at $T = 1\,170$ to 1 530°K in quartz vessels. Above about $T = 1\,400$°K, the reaction is homogeneous and clearly second-order in NO throughout the course of decomposition. A change in the surface to volume ratio leaves the rate unchanged as does the addition of a fourfold excess of nitrogen or helium. Above 1 400°K, the activation energy is constant at $63{\cdot}8 \pm 0{\cdot}6$ kcal. The effect of added oxygen was investigated and a mechanism is discussed which reconciles much of the available data. A.

541.124

10029. Study of chemical reaction mechanisms with molecular beams. The reaction of K with HBr. E. H. TAYLOR AND S. DATZ. *J. chem. Phys.*, **23**, *No.* 9, 1711–18 (*Sept.*, 1955).

The reaction between K and HBr has been studied by a molecular beam technique, using as a detector a surface ionization gauge with a tungsten and a platinum alloy filament, the former sensitive to KBr as well as to K and the latter essentially to K only. The activation energy is $3{\cdot}4 \pm 0{\cdot}1$ kcal/mole and the probability or steric factor is about 0·1. The angular distribution of the KBr suggests that collisions with the H end of the HBr are more often fruitful than other configurations. The total collision cross-section for a beam of K at 504°K in HBr at 401°K is 850×10^{-16} cm^2. A.

541.126

10030. Tritium–carbon monoxide reaction. D. L. DOUGLAS. Letter in *J. chem. Phys.*, **23**, *No.* 8, 1558–9 (*Aug.*, 1955).

Known amounts of tritium, hydrogen and carbon monoxide were kept in pyrex bulbs at (*a*) room temperature, or (*b*) −195°C. The pressure decreased in both cases after 2–3 days, and a white precipitate appeared. The ion pair yields, calculated on the basis of 35 eV required to form an ion pair, were for (*a*) 0·86 and for (*b*) 2·25. Analysis of the reaction products was done by mass spectrometry. Products found, in the order of their peak heights, were, for exp. (*a*) H_2CO, CH_3CHO, HTCO, CH_3TCO, T_2CO CH_2T_2CO, CHT_3CO, CT_4CO, and for exp. (*b*) H_2CO, HTCO, CH_3TCO, CH_3CHO, CH_2T_2CO, CHT_3CO, $(CH_2OH)_2$, T_2CO, CT_4CO, $(CH_2O)_2$. No reaction mechanism is proposed. M. EBERT

541.126 : 534.23

Effects of attenuating materials on detonation induction distances in gases. *See Abstr.* 9500

541.128 : 539.185.9

10031. Catalytic activity induced by neutron irradiation of inert silica. P. B. WEISZ AND E. W. SWEGLER. *J. chem. Phys.*, **23**, *No.* 9, 1567–8 (*Sept.*, 1955).

In pure silica gel, irradiation with 2 to 8×10^{18} fast neutrons/cm^2 produced a significant increase in catalytic activity for the double-bond isomerization in hexane. The effect is believed to be due to lattice dislocations. A.

ELECTROCHEMISTRY 541.13

541.135.5

10032. Explanation of Jolibois' cataphoretic phenomena and the inversion of Hittorf's phenomenon. L.-H. COLLET. Letter in *J. Phys. Radium*, **16**, *No.* 5, 431–2 (*May*, 1955) In French.

Contends that Jolibois' cataphoretic phenomena [*C.R. Acad.* [*Paris*] **212**, 858 (1941); **225**, 609 (1947)] are identical with the author's inversion of the phenomenon of Hittorf [Abstr. 8019 (1953) and *C.R. Acad.* [*Paris*] **232**, 1760 (1951); **239**, 266 (1954); also *J. Chim. phys.*, **49**, C 69 (1952)]. Hittorf's transference numbers are the true transference numbers, not requiring any correction for the effect of hydration. It follows from the author's theory that, for an increase of anodic concentration, a negative cation transference number might be envisaged. The author thinks that, in a solution in the state of equilibrium, the inversion of the phenomenon of Hittorf is only apparent and should be attributed to secondary reactions. F. LACHMAN

541.135.5

10033. Note on the potential of the α-Pd/H_2 electrode. S. SCHULDINER AND J. P. HOARE. Letter in *J. chem. Phys.*, **23**, *No.* 8, 1551–2 (*Aug.*, 1955).

The open circuit p.d. of the electrode against a Pt/H_2 electrode in the same sulphuric acid solution is found to be 0·050 volts. When the Pd/H_2 electode is made by coating Pt with Pd the p.d. is zero. It is suggested that this is because possible solution contact through the pores of the Pd coat would give rise to local cell action between Pt and Pd. In the gas phase the Pd was charged to the β-Pd/H_2 system and was converted to the α form on contact with the solution. W. GOOD

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/.15

541.144.8

10034. Photolysis with a high intensity spark. G. J. MAINS, J. L. ROEBBER AND G. K. ROLLEFSON. *J. phys. Chem.*, **59**, *No.* 8, 733–9 (*Aug.*, 1955).

An apparatus is described in which a capacitance ranging up to 10 microfarads charged to 20 000 volts is discharged between magnesium electrodes in a low-pressure chamber. The light from such a source was found to be predominantly that of the magnesium spark with a particularly high intensity of the doublet near 2 800 Å. Hence for many photochemical reactions this spark can be used as essentially a monochromatic source of this wavelength. The intensity of the light has been studied as a function of the discharge potential, inductance and capacitance. The duration of the discharge is also dependent on these quantities. The maximum average intensity incident on a 100 cm^3 reaction vessel was found to be 10^{21} quanta per second. The apparatus was used to study the photolysis of acetaldehyde. The principal products under these conditions were carbon monoxide, ethane, methane and hydrogen. It is shown that the results are in accord with the idea that all the methyl radicals formed by the primary action of the light on the aldehyde react to form ethane. The ethane yield does not vary appreciably with a thirty-fold change of intensity which indicates that competition between the reaction of methyl radicals with acetaldehyde to form methane and the combination to form ethane is not important at these intensities. A.

541.15

10035. The effect of high γ-radiation dosage on the organic yields of Br^{80}, Br^{80m} and Br^{82} produced by the (n, γ) reaction in *n*-propyl bromide. J. C. W. CHIEN AND J. E. WILLARD. *J. Amer. Chem. Soc.*, **77**, *No.* 13, 3441–52 (*July* 5, 1955).

Pure liquid *n*-C_3H_7Br subjected to high γ-ray exposures before or during neutron irradiation gives abnormally high organic yields for the $Br^{79}(n, \gamma)Br^{80m}$ (4·4 hr), $Br^{79}(n, \gamma)Br^{80}$(18 min) and $Br^{81}(n, \gamma)Br^{82}$(36 hr) processes. The effect is most pronounced for the 36 hr species and least for the 18 min species. It is due to reaction of the HBr or Br_2, formed as a result of the (n, γ) process, with olefin-like species formed from the C_3H_7Br by the γ-radiation. A.

541.15

10036. Radiation stability of plastics and elastomers. C. D. BOPP AND O. SISMAN. *Nucleonics*, **13**, *No.* 7, 28–33 (*July*, 1955).

Data on the sensitivity to radiation of tensile strength, breaking elongation, recovery and crystallinity of elastomers are described. Natural rubber is shown to have greater resistance to radiation damage than the synthetic varieties. The radiation stability of a large number of plastics, as indicated by changes in strength, elongation and Young's modulus, is tabulated. L. R. SHEPHERD

541.15

10037. Oxidation states of phosphorus-32 produced by neutron irradiation of potassium chloride. T. A. CARLSON AND W. S. KOSKI. *J. chem. Phys.*, **23**, *No.* 9, 1596–9 (*Sept.*, 1955).

Investigation shows that like the simultaneously formed S^{35} the ratio of the different oxidation states depends on the preirradiation treatment. Through outgassing of the crystals results in the production of lower oxidation states. On the other hand, the oxidation states of P^{32}, unlike S^{35}, are strongly affected by the presence of X- or γ-radiation. The recoil energy of the newly formed P^{32} fragment seems to have little effect on its final oxidation state. A.

541.15

10038. Radiation induced changes in the structure of poly*iso*butylene. P. ALEXANDER, R. M. BLACK AND A. CHARLESBY. *Proc. Roy. Soc. A*, **232**, 31–48 (*Oct.* 11, 1955).

Poly*iso*butylene suffers random main-chain fracture when exposed to high radiation. Identical results are produced by electron and γ-radiation and the average energy absorbed per break amounts to 20 eV at 20°C. The unsaturation produced is proportional to the number of breaks. A new absorption band appears in the infrared at 11·25 μ, which indicates that a vinyl double bond of the type $R_1R_2C{=}CH_2$ has been introduced. The gases evolved on irradiation have been analysed. A chemical mechanism for the degradation has been proposed. The energy per

break varies with temperature, the relationship being somewhat similar to the inactivation behaviour of ionizing radiation on certain biological systems. The ultraviolet absorption spectrum is different for polymers which have been irradiated in vacuum or nitrogen from those irradiated in air, but the number of main-chain breaks is not affected by the surrounding gas. A.

DISPERSIONS . COLLOIDS . ADSORPTION
541.18

541.182

10039. Electrostatic forces between nonidentical colloidal particles. A. BIERMAN. *J. Colloid Sci.*, **10**, *No.* 3, 231–45 (*June*, 1955).

The Verwey–Overbeek theory is extended to nonidentical particles and shown to be in need of revision. This revision is carried through by introducing an interaction dependent ψ_0. It is shown that attractive forces can arise between nonidentical plates at small distances. The conditions for this attraction and the range of this force are calculated. It is shown that the range can be as large as a few hundred ångströms. A.

541.182.2/.3

10040. The diffusion battery method for aerosol particle size determination. J. W. THOMAS. *J. Colloid Sci.*, **10**, *No.* 3, 246–55 (*June*, 1955).

The diffusion battery consists of a number of long, narrow, parallel channels through which the fluid moves in streamline flow. Measurement of the fractional penetration of a homogeneous, sub-micron aerosol through the battery allows the determination of its diffusion constant and particle size. The object of this work was to investigate the validity of the diffusion method. Circular tube batteries were used to determine diffusion coefficients of gaseous molecules; satisfactory agreement with previous values was obtained. Two parallel plate batteries were used for aerosol particle size measurement in the 0·15 to 0·40μ radius range; data were extrapolated to zero flow rate through the battery. Results checked those obtained by the gravity settling method and standard optical methods in the 0·15 to 0·30μ radius range. Above 0·30μ radius, the batteries gave low results. The diffusion battery is applicable for determining particle size from atomic dimensions to radii of about 0·3μ. Battery construction difficulties, however, essentially limit the method to particles under 0·1μ radius. A.

541.182.2

10041. The role of electric forces in the filtration of aerosols by fiber filters. T. GILLESPIE. *J. Colloid Sci.*, **10**, *No.* 3, 229–314 (*June*, 1955).

The net electric charge on the fibres of various filters and the electric charge distributions of typical test aerosols were measured. A simple theory of filtration which included electric as well as mechanical effects was developed in order to apply these data to appropriate filtration results. Most fibres have an electric charge, even though it may be very small. When the test aerosol in filtration experiments is a homogeneous uncharged aerosol from a La Mer–Sinclair generator, a peak in the per cent penetration *v.* particle radius curves appears at approximately 0·05μ, depending on the velocity of the air through the filter. The presence of electric forces of induction decreases the penetration of large particles and tends to decrease the radius at which maximum penetration occurs. When the aerosol used is a heterogeneous aerosol produced by any of the normal means, the peak in the penetration *v.* particle radius curves appears at larger values of the radius, depending upon the net electric charge per unit length of the fibres and the electric charge distribution of the test aerosol. It is pointed out that some unexplained filtration results may be due to some of the aerosol particles' escaping capture on contact. No attempt was made to assess the part played by electric forces in ensuring adhesion on contact. A.

541.183

10042. Electronic interaction between nitrogen and evaporated films of nickel. R. SUHRMANN AND K. SCHULZ. *Z. Naturforsch.*, **10a**, *No.* 7, 517–21 (1955) In German.

Evaporated films of nickel annealed at 100°C do not adsorb nitrogen at room temp., but at 90°K appreciable, and in part irreversible, adsorption occurs with ~6% increase in electrical resistance. Thus at 90°K there must be a shift of the electrons of the metal towards the nitrogen molecules. S. J. GREGG

541.183

10043. Remarks on the statistical methods of derivation of the function for the distribution of the energy of adsorption on a heterogeneous surface. J. DANON. *J. Chim. phys.*, **52**, *No.* 5, 392–5 (*May*, 1955) In French.

The function for the distribution of the energy of adsorption on a heterogeneous surface is connected mathematically with the adsorption isotherm by an integral equation (I). It is demonstrated that the approximate solution for (I) proposed by Roginsky [*C.R. Acad. Sci. URSS*, **45**, 61 (1944)] represents a particular case of the solution of the general equation of Sips [Abstr. 3495 (1948)]. By introducing certain mathematical restrictions, it is possible to deduce an approximate form of the distribution function if the adsorption isotherm is known in the region of low pressures. Roginski's method is equivalent to neglecting the entropy of configuration of the adsorbed molecules. S. J. GREGG

541.183

10044. The second and third order interaction of a mixture of gases and a surface. T. KWAN, M. P. FREEMAN AND G. D. HALSEY, JR. *J. phys. Chem.*, **59**, *No.* 7, 600–3 (*July*, 1955).

Expressions are developed for the second and third mixed virial coefficients between a solid and a two-component gas mixture. The apparent volume of a vessel filled with a high surface-area powder is developed as a function of mole fraction of the gas mixture and these coefficients. Numerical evaluation of the constants is made on the basis of a cube-law attraction energy with the surface and hard-sphere repulsion for the gases. Experiments are reported for the systems argon–krypton–alumina, argon–methane–charcoal and argon–nitrogen–charcoal. The agreement is satisfactory. A.

541.183

10045. Adsorption of strontium and of barium on tungsten. G. E. Moore and H. W. Allison. *J. chem. Phys.*, **23**, *No.* 9, 1609–21 (*Sept.*, 1955).

Sr or Ba was deposited on W ribbon receivers by evaporation from source filaments in which a chemical reaction produced the metal at least 99·7% pure. The receiving surfaces could be cleaned at will by heating to high temperatures; repeated tests were thus possible. By thermionic measurements, adsorption and desorption were observed independently under non-equilibrium conditions. By using radioactive Sr isotopes, the deposit corresponding to any thermionic activation was measured. For each ribbon, thermionic activation was apparently a reversible function of the amount adsorbed. The experimental methods give information on kinetics, rather than equilibria. The adsorption mechanism more nearly resembles that proposed in Langmuir's later papers rather than that of his earlier theories, but treatment of desorption by the theory of absolute reaction rates is considerably more satisfactory. This accounts for desorption kinetics over the experimental temperature range by only two disposable constants, the activation energy for desorption (a.e.d.) and a repulsive energy of interaction between adatoms. The work function ϕ for a monolayer of Sr is $\sim$2·2 V and for Ba is $\sim$1·9 V. The thermionic activation is explained in terms of polarized adatoms, rather than by the usual assumption of partial ionization, which has no experimental justification for Ba or Sr films. The theory proposed gives a reasonable value for the polarizability of Sr and of Ba, which when substituted into the theory of Prosen, Sachs and Teller predicts a heat of physical desorption agreeing well with the observed a.e.d. This also agrees with the heat of desorption (h.d.) determined by the usual method of applying the Clapeyron equation to kinetics of this kind. It is therefore believed that this adsorption should be called "physical," rather than "chemical," although the mean a.e.d.'s are, for Sr 77·4 and for Ba 80·7 kcal/mole, considerably larger than for most examples of chemisorption. A.

541.183.022 : 541.64

10046. Properties of surface films of macromolecular substances. F. H. Müller. *Z. Elektrochem.*, **59**, *No.* 4, 312–29 (1955) In German.

A review of the work on the behaviour of high polymers in the Langmuir trough. The hysteresis of the pressure-area diagram is discussed, and the behaviour of various polymers is related to their hydrophilic character, the size and shape of the molecules and their tendency to crystallize. Methods of determining the molecular weight of high polymers on the Langmuir trough are mentioned. Some new results on the behaviour of mixtures are given and the paper is followed by a discussion. P. CUCKA

541.183.5

10047. Adsorption of helium on titanium dioxide. J. G. Aston, S. V. R. Mastrangelo and R. J. Tykodi. *J. chem. Phys.*, **23**, *No.* 9, 1633–5 (*Sept.*, 1955).

The adsorption characteristics of helium adsorbed on TiO_2 (anatase) have been studied in the temperature range 2°–20°K. Isotherms are reported at 2·60°, 4·17°, 13·96° and 20·28°K. Isosteric heats of adsorption at low coverage have been measured at 17·1°K. The data are interpreted in terms of a previously discussed model. A.

CHEMICAL STRUCTURE 541.2/.6

541.5

10048. The valence-states of some elements from groups 2, 3 and 4; configurations containing *d*-orbitals. H. A. Skinner. *Trans Faraday Soc.*, **51**, *Pt* 8, 1036–42 (*Aug.*, 1955).

Valence-state excitation energies are calculated for the atoms Mg, Ca, Zn, Sr, Al, Sc, Ga, Y, Ti, and for a number of isoelectronic ions. Alternative valence-states are available to these atoms, but whereas those built up from *s*- and *p*-electrons are the most easy of attainment in the second-row and sub-group *B* elements, in the sub-group *A* elements, configurations containing *d*-orbitals are generally the most accessible. The bonding orbitals of these elements are considered as isovalent hybrids, and the character of the hybridization is discussed qualitatively. A.

541.64

10049. Note on singular integral equations of the Kirkwood–Riseman type. P. L. Auer and C. S. Gardner. Letter in *J. chem. Phys.*, **23**, *No.* 8, 1545–6 (*Aug.*, 1955).

It is pointed out that if $0 < \alpha < 1$, then the kernel of the integral equation has a convenient diagonal representation in terms of certain polynomials related to Legendre polynomials. W. GOOD

541.64

10050. Solution of the Kirkwood–Riseman integral equation in the asymptotic limit. P. L. Auer and C. S. Gardner. Letter in *J. chem. Phys.*, **23**, *No.* 8, 1546–7 (*Aug.*, 1955).

It is shown that for $\alpha = \frac{1}{2}$, and in the limit of large molecular wt of the polymer chain, the solution may be accomplished by using the Gegenbauer polynomial expansion (see preceding abstract). W. GOOD

541.67 : 538.082

10051. The influence and the elimination of the ferromagnetic susceptibility in magneto-chemical investigations by the cylinder method. A. Knappwost. *Z. Elektrochem.*, **59**, *No.* 6, 561–4 (1955) In German.

It is shown that in all cases of not too high concentrations of ferromagnetic impurities the cylinder method of measuring the susceptibility of a substance can be retained if appropriate corrections are applied to the plot of κ against $1/H_{max}$. The method gives results in excellent agreement with the more experimentally difficult field difference method. W. GOOD

CHEMICAL ANALYSIS 543/545

545.71

10052. Measurement of metallurgical equilibria by thermal conductivity gas analysis. J. W. Evans. *Brit. J. appl. Phys.*, **6**, *No.* 10, 364–5 (*Oct.*, 1955).

A gas thermal conductivity cell is used to measure

the high temperature equilibria between metal oxides and carbon monoxide/carbon dioxide gas mixtures. A.

545.82 : 535.34.07

A new approach to infra-red instrumentation. *See Abstr.* 9560

545.822

10053. The carriers of the flame spectra of the alkaline earth metals. A. LAGERQVIST AND L. HULDT. Letter in *Naturwissenschaften*, **42**, *No.* 12, 365–6 (1955) In German.

The band spectrum of a Sr salt in an acetylene flame was photographed at high dispersion and wavelengths of the bands at 6114 to 6105 Å measured. When D_2O was used to dissolve the salt instead of H_2O, an extra set of bands appeared with edges at wavelengths about 3 to 5 Å longer than the main set. These are attributed to SrOD and SrOH respectively. Similarly CaOH and BaOH are considered responsible for the other flame spectra. S. T. HENDERSON

545.822

10054. Attempt to classify by means of their infra-red absorption spectra, ordinary tartar emetic and various antimony and bismuth complexes. M. GIRARD AND J. LECOMTE. *C.R. Acad. Sci.* [*Paris*] **241**, *No.* 3, 292–4 (*July* 18, 1955) In French.

The presence of the ionized carboxyl group in various compounds is indicated by bands in the region 1 325 and 1 385 cm^{-1}. G. F. LOTHIAN

545.844

10055. A fraction collector for chromatography. E. T. SANDERS. *J. sci. Instrum.*, **32**, *No.* 10, 392–3 (*Oct.*, 1955).

An instrument is described which collects, weighs and dispenses successive fractions of liquid from a chromatographic column into a series of test tubes. The fractions are separated on a weight basis and the entire operation is automatic. A.

CRYSTALLOGRAPHY 548

548.2 : 548.735

10056. On the relations between structure and morphology of crystals. II. P. HARTMAN AND W. G. PERDOK. *Acta cryst.*, **8**, *Pt* 9, 521–4 (*Sept.*, 1955).

For Pt I, see Abstr. 4169 (1955). The characteristic features of *S*-faces (stepped faces, i.e. faces parallel to one periodic bond chain only) are further developed. After giving some definitions, a discussion follows of the factors determining the morphological importance of *S*-faces. The conclusion is drawn that the development of *S*-faces in a particular zone can be represented by an addition scheme of indices and that an *S*-face is the more important, the greater the relative strength of the bonds in the periodic bond chain to which it is parallel. An outline is given of the way in which the morphology of an actual crystal can be derived from the structure. This is illustrated in the case of cubic closest packing. The result is that the octahedron is the most important form, followed by the cube, provided crystallization takes place from the vapour. Crystallization from the melt involves the consideration of pre-condensation effects. In this case the influence of the strongest bond on the morphology diminishes and weaker bonds become more important. This leads to a preponderance of the cube, a relation actually observed with copper. A.

548.2 : 548.735

10057. On the relations between structure and morphology of crystals. III. P. HARTMAN AND W. G. PERDOK. *Acta cryst.*, **8**, *Pt* 9, 525–9 (*Sept.*, 1955).

The morphology of barite is deduced from the structure. It is found that there are six *F*-forms, namely {001}, {010}, {211}, {210}, {101} and {100}. An estimate of the relative importance of these faces is obtained by approximate calculations of the attachment energies. The results are in satisfactory agreement with observations. The form {011} is found to be a *K*-face. Its relatively high morphological importance is explained in terms of dehydration and impurity effects. All other forms of some importance appear to be *S*-forms. Crystals of some compounds isotype with varite, grown from pure aqueous solutions, show only the six *F*-forms, and {011} due to the dehydration effect. This suggests the assumption that the occurrence of *S*- and *K*-forms on minerals is due to a period of dissolution followed by growth in an impure environment. A.

548.5

10058. Two contributions on the question of crystal growth. A. G. SMEKAL. *Z. Elektrochem.*, **59**, *No.* 5, 419–21 (1955) In German.

The equality of the activation energies for nucleation and for growth of new crystals on a deformed crystal implies growth from invisible pre-existing nuclei. The differences in behaviour of identical specimens under different thermal treatments implies that thermal fluctuations have some effect as well as crystal structure in the region of the nucleus. Observations on the terraced growth of dendrites in melts of NaCl show the terrace height to be less than 0·02 μ, and that there is no corresponding internal lamellar structure. The step edge is usually rounded. The precise form and height depends on temperature and purity, and any explanation must involve considerations of surface mobility and redissolution.

W. M. LOMER

548.5

10059. On some properties of ethylene diamine tartrate (EDT) crystal growth. E. KLIER AND M. SHAKI. *Czech. J. Phys.*, **5**, *No.* 3, 404–17 (*Aug.*, 1955).

After a brief survey of the theories of crystal growth the paper gives some characteristics of the growth of EDT crystals on the basis of the authors' experiments and an explanation from the point of view of various theories. It also deals with questions of growth of crystal caps, with components of the growth rate, the veiling and splitting of growing caps, the influence of impurities, the growth of edges and corners and their stability. A.

548.5

10060. Growth features on crystals of long-chain compounds. I. S. Amelinckx. *Acta cryst.*, **8**, *Pt* 9, 530–7 (*Sept.*, 1955).

A description is given of growth features, observed with phase-contrast microscopy, on crystals of *n*-alcohols ($C_{22}H_{45}OH$, $C_{24}H_{49}OH$ and $C_{26}H_{53}OH$) grown from solutions in benzene and xylene. In this first part special attention is given to interlaced spirals on crystals of the β-form (monoclinic) of the *n*-alcohols. In a second part, growth features observed on crystals of the α-form (orthorhombic) as well as on carboxylic acids will be treated with special reference to imperfect dislocations and to twin growth. It is shown how the analysis of the growth patterns can lead to unambiguous conclusions concerning the stacking sequence of particular crystals. It is concluded that these crystals exhibit a remarkable polytypism due to spiral growth and to the presence of stacking faults of a well defined type, i.e. relative rotations through angles $\phi = k \times 60°$ between successive bimolecular layers. A.

548.5 : 548.74

10061. An electron diffraction study of the structure of electro-deposited nickel. I. B. C. Banerjee and A. Goswami. *J. sci. industr. Res.*, **14B**, *No.* 7, 322–4 (*July*, 1955).

The structure and orientation of electro-deposited nickel from a sulphate–boric acid bath have been studied under varying conditions of pH, temperature and current density. Conditions which affect the crystal structure and orientation, and hence the mode of growth of the deposit, have been determined. A.

548.52

10062. Screw dislocations in growth from the melt. G. W. Sears. *J. chem. Phys.*, **23**, *No.* 9, 1630–2 (*Sept.*, 1955).

The screw dislocation growth mechanism is shown to be operative for the growth from the melt of certain faces of PbI_2 at small supercoolings. A.

548.55 : 537.311.33

Preparation and electrical properties of CdTe single crystals. *See Abstr.* 9653

548.574

10063. The interpretation of etch patterns on aluminium. A. J. Forty and F. C. Frank. *J. Phys. Soc. Japan*, **10**, *No.* 8, 656–63 (*Aug.*, 1955).

An examination of etch patterns obtained with Lacombe's etchant on polycrystals of "super-purity" aluminium suggests that an etch pit is produced only where there is a precipitate of impurity present in the surface, and that these are located on dislocations which can therefore be regarded as an indirect cause of etching. It is tentatively estimated that, at best, only about 60 or 70% of the dislocations in super-purity Al produce etch pits. A.

ATOMIC AND X-RAY CRYSTALLOGRAPHY 548.7

548.7 : 536.7

10064. On Onsager's theory of a lattice of dipoles. V. L. Pokrovskiĭ. Letter in *Zh. éksper. teor. Fiz.*, **28**, *No.* 4, 501–3 (1955) In Russian.

Discusses the extension of Onsager's theory [*Phys. Rev.*, **65**, 117–49 (*Feb.* 1 *and* 15, 1944)] to three or more dimensions, and concludes that the second-order transition which is found in two dimensions (with only nearest neighbours interacting) will not occur in three. J. M. Radcliffe

548.7

10065. The combinatorial method and the two-dimensional Ising model. R. B. Potts and J. C. Ward. *Progr. theor. Phys.*, **13**, *No.* 1, 38–46 (*Jan.*, 1955).

A combinatorial method is used to calculate (*a*) the partition function of a finite rectangular Ising lattice [shown previously in Abstr. 2811 (1953)], and (*b*) the correlation functions of an infinite lattice as well. A.

548.7

10066. A method for the evaluation of some lattice sums occurring in calculations of physical properties of crystals. II. G. C. Benson and H. P. Schreiber. *Canad. J. Phys.*, **33**, *No.* 9, 529–33 (*Sept.*, 1955).

For Pt I, see Abstr. 1836 (1954). The methods of Pt I are applied to the evaluation of lattice sums of the form $\sum_{k,l}^{\infty} \sum_{m}^{-\infty\infty} k^r l^s (k^2 + l^2 + m^2)^{-n}$ (r and s positive integers). Useful transformations result when either r or s is even but not in general when both r and s are odd. A table of the function $\delta_t(\infty) = \sum_{k,l}^{\infty} kl(k^2 + l^2)^{-t/2}$ for integral values of t from 5 to 30 is presented. This permits the extension of the method to the cases $r = 1$, $s = 1$ and $r = 1$, $s = 3$. A.

548.7 : 539.11

10067. The structure of ice. R. E. Rundle. *J. phys. Chem.*, **59**, *No.* 8, 680–2 (*Aug.*, 1955).

Problems connected with the structure of ice are reviewed, particularly the problem connected with residual entropy and polar *v.* non-polar structures. It is shown that if, at low temperature, ice is truly hexagonal, then there is a good reason to believe it is polar. A polar structure is attractive in explaining some of the physical properties of ice, but it leaves the the residual entropy problem unsolved (though not hopeless), while the non-polar structure leaves some physical properties unexplained, but accounts for the entropy. A.

548.7

10068. Effects of temperature on some hydrogen-bond networks in crystals. K. Gallagher, A. R. Ubbelohde and I. Woodward. *Acta cryst.*, **8**, *Pt* 9, 561–6 (*Sept.*, 1955).

Observations on acetylene dicarboxylic acid dihydrate show that the crystal form (α) ordinarily obtained is stable from the melting point (about +40°C) down to about +3°C. Below this range, X-ray reflections reveal a continuous transformation to a new (β) polymorph. Intensity measurements show marked hysteresis in a thermal cycle including this change. At around −40°C there is a further discontinuous transformation to a third (γ) polymorph. Dielectric measurements on the powders do not indicate the onset of ferro-electric properties at either transition. The dihydrates of oxalic acid and of α acetylene dicarboxylic acid contain a structurally similar network of hydrogen bonds. In

order to compare the thermal behaviour of these two networks, thermal expansions have been measured for the two crystals in all directions for which they were not previously known. In spite of the differences in the acid residues, the thermal expansions of the two crystals are closely similar. One dominant effect in both crystals appears to be the sensitiveness of short hydrogen bonds to their vibrational energy content. In both crystals, directions of maximum thermal expansions in the sections of the expansion ellipsoid by the (010) plane and directions of the maximum isotope effects in this plane lie near to directions of the short hydrogen bonds. At right angles to these maximum expansions, in the (010) plane, expansions are much smaller. Both crystals also show marked thermal expansion along the symmetry (*b*) axis. This appears to be a property of the helices of hydrogen bonds joining the molecules in the crystals. A.

548.7 : 539.132

A method for calculating thermal vibration amplitudes and spectroscopic data. *See Abstr.* 9801

548.7 : 530.145

Radiation theory in crystals. *See Abstr.* 9415

548.7 : 539.11

10069. Formation energy of superlattice in Ni_3Fe. IV. A theoretical treatment of vacancy migration and disorder-order transformation in alloys. S. Iida. *J. Phys. Soc. Japan*, **10**, *No.* 9, 769–85 (*Sept.*, 1955).

For Pt III, see Abstr. 3259 (1955). In Section I, the disorder-order transformation of the AB-type superlattice was studied by postulating an elementary mechanism of atomic diffusion through vacancy, that is, the exchange of a vacancy and its neighbouring atom. The height of potential for the atomic migration was assumed to be a constant plus nearest neighbour energies of the atom. The kinetics of the ordering was treated in an approximation which is equivalent to the Bethe–Peierls' approximation. This is described by five differential equations to determine five time-dependent variables, three of which are concerned with vacancies. By solving these equations, it was shown that if an AB-type alloy is quenched from a high-temperature disordered state to a temperature somewhat below the critical temperature, and then annealed at that temperature, the following disorder-order transformation will exhibit a multiple-step character. In Section II, this prediction was compared with the experimental results of Ni_3Fe. It was found that the theory can describe at least qualitatively, each of the observed four stages of the disorder-order transformation at 490°C of this alloy. Namely, the first stage is the abrupt change in the state of imperfections, the second, the development of short-range order without long-range order, the third, the cooperative formation of long-range order, and the fourth, the process to complete its long-range order against the retarding effect of antiphase and imperfections. A.

548.7

10070. Exciton spectra in crystals. S. Nikitine. *Helv. phys. Acta*, **28**, *No.* 4, 307–11 (1955) In French.

548.7

10071. Electronic states of the naphthalene crystal. D. S. McClure and O. Schnepp. *J. chem. Phys.*, **23**, *No.* 9, 1575–87 (*Sept.*, 1955).

The existing experimental data on the low-temperature fluorescence and absorption of naphthalene crystal is reviewed and correlated with the authors' own data. Some preliminary work on crystals of $C_{10}D_8$ is included. A vibrational analysis of the first moderately strong absorption region, 31 476–33 700 cm^{-1} is made on the basis of the corresponding absorption of naphthalene in solid solution with durene. Some constants of the exciton theory of molecular crystals are obtained for the first and second excited singlet molecular states. Some discrepancies with the theory are pointed out; one of these is removed by calculating the crystal induced mixing of the two excited molecular states. Factor group splitting is found for certain vibronic levels of the ground and first excited state, but most vibronic levels of these states do not split appreciably. A.

548.7 : 535.323

Optical anisotropy of aromatic crystals. *See Abstr.* 9538

548.7 : 536.422

10072. Evaporation of trace impurities from the matrix of a host lattice. K. P. Sinha and A. K. Dasgupta. *J. sci. industr. Res.*, **14B**, *No.* 7, 320–2 (*July*, 1955).

Impurity ions having larger sizes than the ions of the host lattice lie in regions of distortion and are subject to higher overlap forces. It is suggested that due to inelastic interaction with phonons at higher temperatures, the impurity ions migrate to the surface from which they eventually escape. The results of experiments conducted with radioactive rubidium as impurity in sodium and potassium chloride crystals confirm the above postulation. A.

548.7

10073. Deformation-induced charge flow in NaCl crystals. D. B. Fischbach and A. S. Nowick. Letter in *Phys. Rev.*, **99**, *No.* 4, 1333 (*Aug.* 15, 1955).

Plastic deformation of NaCl single crystals causes a transient current flow if the deformation is inhomogeneous. Direction of current flow in the external current is away from the side of the crystal at which the high stress occurs, even in the presence of opposing applied fields up to 10^7 V/cm. It is suggested that flow of positively charged dislocations occurs, leaving behind a net excess of positive ion vacancies.

G. F. J. Garlick

548.7

10074. Slow motion of dislocation in face-centred cubic crystal. H. Suzuki. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **7**, *No.* 2, 194–203 (*April*, 1955).

The slow motion of an extended dislocation accompanied by heterogeneous distribution of solute atoms in its hexagonal layer was studied on the basis of the interaction mechanism between solute atoms and dislocations proposed by the present author. In the case of a very small stress, the velocity v was expressed by $v = 0{\cdot}4(D/b)(f/f_0)$, where D is the diffusion coefficient of the solute atoms in the alloy, b the strength of the perfect dislocation, f the applied

shear stress, f_0 the critical shear stress of the alloy due to the locking force by solute atoms. The slow motion of an extended dislocation might be stable under an applied force less than $0{\cdot}6 \sim 0{\cdot}8 f_0$, depending on the width of the extended dislocation. A.

548.7 : 771.535

10075. Photo-chemistry with X-rays in sensitized KBr crystals. W. MARTIENSSEN AND H. PICK. *Royal Photographic Society International Conference* [*London*] 110–12. See Abstr. 7586 (1955).

KBr crystals sensitized with very small amounts of KH were irradiated with X-rays of 60 kV, and their absorption spectra measured. The products of the photochemical reaction are not *F*-centres and *V*-centres as in pure alkali halides, but *F*-centres alone. Instead of a production of *V*-centres there is a destruction of KH centres. The energy necessary for the formation of an *F*-centre can be deduced from the slope of the curves showing *F*-centre concentrations as functions of irradiation and KH concentration. In the beginning of the reaction the formation energy is independent of these two variables, i.e. all liberated defect electrons are captured by the sensitizer. Later some *F*-centres act as traps for defect electrons; this counter-reaction gradually (with increasing concentration of the *F*-centres) suppresses the main reaction. A.

548.73/.74

X-ray and electron investigation of materials. *See also under* "Structure of solids." Decimal classification 539.26/.27

548.73 : 539.32

10076. Factors determining the choice of X-ray reflexions for the study of the elastic properties of certain non-cubic crystals. S. C. PRASAD AND W. A. WOOSTER. *Acta cryst.*, **8**, *Pt* 10, 614–16 (*Oct.*, 1955).

The procedure necessary for the determination of the elastic constants of crystals belonging to the orthorhombic system is considered. It is shown that six of the nine elastic constants can be obtained from measurements which depend on only the particular elastic constant under consideration; the remaining constants can be found from measurements which depend on several elastic constants. In the cubic, tetragonal and hexagonal systems the constant c_{12} may be simply determined from a measurement depending only on $(c_{11} - c_{12})$. The relative accuracy with which the constants can be determined is also discussed. A.

548.732 : 518.5

10077. Nomographs for the determination of wavelength for highest angle X-ray diffraction. L. MULDAWER AND R. FEDER. *Rev. sci. Instrum.*, **26**, *No.* 9, 827–9 (*Sept.*, 1955).

A single operation technique is presented for the determination of wavelength for highest angle diffraction of cubic materials. This method makes use of a chart with the lattice parameter as ordinate and $(\lambda/2 \sin\theta)$ as abscissa, lines being drawn for each $(h^2 + k^2 + l^2)$. For noncubic materials, a chart is prepared with lattice spacing as ordinate and $(1/\sin\theta)$ as abscissa, lines being drawn for each wavelength. Separate settings must be made for each spacing in this second case. A.

548.733

10078. Reflection from X-ray spectrometer crystals. E. KAUER. *Z. angew. Phys.*, **7**, *No.* 8, 386 (1955) In German.

In order to facilitate optical adjustment the spectrometer crystal is given a thin aluminium layer on its reflecting face. The optimum thickness of this layer is discussed. A. R. STOKES

548.733

10079. New aids in X-ray interference measurements with the counter goniometer. R. BERTHOLD. *Z. angew. Phys.*, **7**, *No.* 9, 443–6 (1955) In German.

Describes a powder-specimen vibrator for smoothing the Debye-Scherrer lines of coarse-crystal specimens; a specimen-holder which enables a flat specimen to be rotated in its own plane for texture studies; and an attachment for spectrum analysis. A. R. STOKES

548.733

10080. Measurements by X-ray optics of ideal crystals. I. Confirmation of the Darwin–Ewald–Prins–Kohler-curve. M. RENNINGER. *Acta cryst.*, **8**, *Pt* 10, 597–606 (*Oct.*, 1955) In German.

A three-crystal diffractometer was constructed and is described. The first two reflections in (2, +2) order on two selected calcite cleavage surfaces serve to produce a beam of very small spectral and angular width which is used as a "tool" for the investigation of the wider diffraction pattern (reflection curve) of a third calcite crystal in first-order reflection. The full width at half maximum of the (2, −2) rocking curve of the first two crystals is 2·5 in., so that, cutting out a small spectral section from the Cu$K\alpha$, in the (2, +2) reflection, the details of the diffraction pattern of a third crystal can be studied in the (2, +2, ±1) positions. This curve has a width of about 7 in. and shows the flat, sloping, asymmetrical plateau and shoulders predicted by the dynamical theory including absorption. A quantitative comparison of the experimental and theoretical reflection curves is given. In confirmation of observations by Bearden and Roseberry and Parratt it is found that the cleavage planes of calcite deviate irregularly from parallelism to the (211) net planes by several minutes of arc. Irregularities in the orientation of the faces are no indication of parallel irregularities in lattice orientation, i.e. no indication of block structure. A.

548.734

10081. A technique for obtaining X-ray powder photographs of compounds of high specific activity. K. W. BAGNALL AND R. W. M. D'EYE. *Atomic Energy Res. Establ.* [*Harwell*] *Mem. C/M*238, 3 *pp.* (1955).

A simple arrangement of standard X-ray equipment and a method of mounting highly active samples is described with special reference to polonium compounds. A.

584.734

10082. The accuracy of structures determined by powder methods, with reference to the Ag–Zn ζ structure. I. G. EDMUNDS. Note in *Acta cryst.*, **8**, *Pt* 9, 595–6 (*Sept.*, 1955).

548.735

10083. The statistical method in crystallography. I. E. F. BERTAUT. *Acta cryst.*, **8**, *Pt* 9, 537–43 (*Sept.*, 1955) In French.

Two general theorems are enunciated on the probability of the value of certain functions. From these a concise mathematical formulation of the statistics of structure factors and of the joint probability of structure factors are deduced. By means of a characteristic function the correlation between structure factors has been systematized and the results of Hauptman and Karle extended. A.

548.735

10084. The statistical method in crystallography. II. Some applications. E. F. BERTAUT. *Acta cryst.*, **8**, *Pt* 9, 544–8 (*Sept.*, 1955) In French.

The theory of the joint probability of structure factors (known or unknown) is applied to the following problems: the establishment of a statistical relationship more exact than that of Woolfson; the determination of the signs of structure factors in space group $P\bar{1}$; the effect of higher symmetries and the study of useful relationships arising from additional symmetry elements and not requiring a knowledge of phases. A.

548.735

10085. The structure of Guinier–Preston zones. I. The Fourier transform of the diffuse intensity diffracted by a Guinier–Preston zone. K. TOMAN. *Acta cryst.*, **8**, *Pt* 9, 587–91 (*Sept.*, 1955).

The expression for the diffuse intensity diffracted by the Al–Cu alloy with Guinier–Preston zones is derived as a trigonometrical series with coefficients dependent on the structure. It is shown that the coefficients can be determined with the aid of the Fourier transform of the integrated diffuse intensity in relrod (00*l*). From these coefficients it is possible to deduce the features which are characteristic of the structure of Guinier–Preston zones. A.

548.735

10086. On the influence of the packing on the atomic scattering factor based on the Thomas–Fermi theory. K. UMEDA AND Y. TOMISHIMA. *J. Phys. Soc. Japan*, **10**, *No.* 9, 753–8 (*Sept.*, 1955).

The influence of juxtaposition in the crystal on the atomic scattering factor has been investigated on the basis of the Thomas–Fermi theory, using the TF functions appropriate to the packed neutral atoms. It is specially pronounced for the smaller values of $\sin\theta/\lambda \,.\, Z^{-1/3}$. The values of the atomic scattering factor for the free neutral atom have been recalculated, using the most accurate Miranda values of the free neutral TF function. A.

548.735.4

10087. The use of general programmes for crystallographic calculations on the Manchester University electronic digital computer (Mark II). F. FOWWEATHER. *Acta cryst.*, **8**, *Pt* 10, 633–7 (*Oct.*, 1955).

A general programme is described for computing Patterson and Fourier syntheses. It can be applied to centrosymmetric and non-centrosymmetric space groups without modification so that there is no need to check programmes for different space groups. Examples with times of computation are given. An application of the programme to diffraction-broadening corrections of superlattice reflections is also described. The second general programme computes structure factors in zones of reflections of triclinic, monoclinic and orthorhombic space groups. The computing time is 2–3 sec per reflection, and printing out of indices and structure factor takes 2·4 sec. A.

548.735.4

10088. Karle–Hauptman inequalities and Euclidean geometry. G. VON ELLER. *Acta cryst.*, **8**, *Pt* 10, 641–5 (*Oct.*, 1955) In French.

Structure-factor inequalities are formulated which are simpler than those of Karle and Hauptman but which are nevertheless rigorously equivalent to them for centro-symmetrical structures. Furthermore, the condensation of the general determinant facilitates the establishment of inequalities of higher order. A.

548.736

10089. Recent experiments on graphite. R. ARNOLD. *Z. angew. Phys.*, **7**, *No.* 9, 453–60 (1955) In German.

Review article. 57 refs.

548.736 : 771.535

10090. Change in lattice dimensions of photographic emulsion grains irradiated with X-rays. C. R. BERRY. *Royal Photographic Society International Conference* [*London*] 113–16. See Abstr. 7586 (1955).

Measurements were made of the diffraction angle of X-rays reflected from the (420) planes of the crystals in a very fine-grain emulsion of low sensitivity. The diffraction peak may be recorded by a Geiger counter with sufficient speed so that a large proportion of the grains do not absorb any of the measuring radiation. When a comparison is made between the diffraction angle of the grains of an emulsion which has not absorbed an appreciable amount of radiation and that of an emulsion which has been pre-exposed to X-rays, it is found that a decrease in lattice constant as great as about 0·003% may be produced by pre-exposure. To increase the accuracy of this result, a large number of measurements were made. Interpretation of the lattice-constant change in terms of various latent-image theories is given. A.

548.736.1

10091. Contribution to the knowledge of X-ray pattern difference between the two types of diamond. M. RENNINGER. *Acta cryst.*, **8**, *Pt* 10, 606–10 (*Oct.*, 1955) In German.

Extreme representatives of type I and type II diamonds have been used for measuring the intensities of reflected X-rays. In all strong reflections the observed large differences of reflecting power (type II stronger than type I) are readily explained by the well-known difference of perfection of the two types. Type I, with strong primary extinction, approaches the extreme of the perfect crystal, type II that of the ideal mosaic crystal. Contrary to the findings of other authors "indirect reflection" (*Umweganregung*) of (222) occurs in both types, though at very different rates. This again can be explained by the differences of perfection. The reflecting power of (222), when unperturbed by simultaneous reflections, yields a structure factor of 1·1–1·2 electrons per cell, in confirmation of an earlier determination by the author. This is now shown to be the same for both

types. The assumption of a difference of electron-density distribution in the two types is thus in no way supported. A.

548.736.3 : 537.312.5

10092. Conductivity measurements, spectrographic and X-ray investigations on zinc sulphide crystals. J. KRUMBIEGEL AND K.-H. JOST. *Z. Naturforsch.*, **10a**, *No.* 7, 526–9 (1955) In German.

In all the crystals investigated, a conductivity maximum is seen at 3 520 Å, despite differences in luminescence colour. Spectrographic analysis of the crystals is quoted, and X-ray investigations show that stacking faults occur; there are regions with two-fold, three-fold and four-fold stacking repeats of the close-packed sheets. W. M. LOMER

548.736.4

10093. Crystal structure and phase transition of some metallic halides. III. Structure anomaly in α–Ag_2HgI_4. S. HOSHINO. *J. Phys. Soc. Japan*, **10**, *No.* 3, 197–200 (*March*, 1955).

By a precise measurement by X-ray G.M. spectrometer of reflection intensities in α–Ag_2HgI_4, it was found that the relative intensity of Debye lines cannot be explained by zincblende type structure with disordered metallic atoms as was assumed previously by Ketelaar. The experimental result was explained by assuming the structure anomaly common to that has been proposed for certain other metallic halides (CuI, CuBr, etc.) manifesting a similar peculiarity of line intensities. It was suggested that there may be correlation between the structure anomaly and the anomalously high ionic conductivity of this crystal. A.

548.736.4

10094. X-ray studies on the structures of solid solutions NaCl–$CaCl_2$. II. Structures of {111} and {310} plate-zones. K. SUZUKI. *J. Phys. Soc. Japan*, **10**, *No.* 9, 794–804 (*Sept.*, 1955).

For Pt I, see Abstr. 3286 (1955). Structures of {111} and {310} plate-zones explaining the rod distributions of intensity weight in reciprocal space revealed in X-ray patterns from solid solutions of NaCl containing a few per cent of $CaCl_2$ (reported in Pt I) is proposed. The plate-zones are considered to be composed of a number of smaller units, called platelets, which are disposed in anti-phase relation among themselves in a plate-zone. Probable models of the structures of the two kinds of platelets are proposed, making up the {111} plate-zone and the {310} plate-zone, respectively, by assuming that each platelet has crystal structure resembling that of $CaCl_2$, retaining, however, coherency with the matrix. Qualitative agreement was found between observed and calculated intensities of rod distributions in reciprocal space. The proposed $CaCl_2$-like structure of the {111} platelet seems to be a plausible one, since it was found that its orientation was followed by that of $CaCl_2$ particles precipitated by a certain heat treatment. In the case of the ⟨310⟩ rods, the proposed structure of the [310] plate-zones is rather tentative. Absolute intensity of the ⟨111⟩ rods was roughly estimated by comparing it with that of thermal diffuse scattering from pure NaCl crystal. It was found that the intensity of the diffuse spots due to the rods could be expected to be of the same order as that of thermal diffuse scattering even when only a few per cent of the dissolved Ca^{++} ions are participating in the {111} plate-zones. A.

548.737

10095. Anomalous X-ray scattering at wave-lengths far from an absorption edge. S. W. PETERSON. Letter in *Nature* [*London*] **176**, 395 (*Aug.* 27, 1955).

See Abstr. 9790 (1954). In the course of experiments conducted with l-tyrosine hydrochloride, l-tyrosine hydrobromide and rubidium hydrogen tartrate, using Cu, Cr and Mo radiations, it has been found that anomalous scattering effects can be observed at wavelengths far from the absorption edges of the heavy atom present in the crystal. The observations were made with the aid of a zero-layer Geiger counter. Figures obtained for F^2_{0kl} and $F^2_{0\bar{k}l}$ for both tyrosine compounds agree well with $\Delta(F^2)$ calculated under certain assumptions. The significance of these findings for direct structure determination by Fourier synthesis in the non-centrosymmetrical case is stressed. F. LACHMAN

548.74 : 539.234

10096. Anomalous lattice spacings caused by stacking disorder. H. NIMURA. *J. Phys. Soc. Japan*, **10**, *No.* 8, 642–6 (*Aug.*, 1955).

Evaporated metal crystallites (gold, silver and aluminium) were studied by means of electron diffraction. As previously reported by Williams [Abstr. 1968 (1952)], measured spacings deviated from the cubic formula by the order of 0·1% for gold and silver while no deviation was detected for aluminium. The deviation was attributed to stacking faults in crystallites, while Williams attributed it to a dislocation line penetrating through a crystallite. A.

GEOPHYSICS 55

550.371

10097. The charge on the earth. J. F. CLARK AND J. H. KRAAKEVIK. Note in *J. atmos. terrest. Phys.*, **6**, *No.* 6, 344–5 (1955).

By the application of Gauss's theorem it is shown that the total charge on the earth must be zero provided that there is no net space convection current. On this hypothesis it is possible to calculate the earth's negative charge from a consideration of thunderstorm data. Such a calculation leads to a smaller value than that obtained by calculations based on the earth's fair weather field. J. M. HOUGH

550.371

10098. Apparatus for the accurate and continuous measurement of the earth's electric field. W. W. MAPLESON AND W. S. WHITLOCK. *J. atmos. terrest. Phys.*, **7**, *No.* 1–2, 60–72 (*Aug.*, 1955).

Two new instruments of the "field mill" type, for the accurate measurement of the earth's electric field,

are described. One mill, designed for operation in fair weather, gives a galvanometer deflection of ± 5 cm for a field of ± 250 V/m with an accuracy of $\pm 2\frac{1}{2}$ V/m with half-hourly calibration. The response time is about one second. The other mill, designed to work in all weathers, has a maximum sensitivity of ± 10 cm deflection for ± 75 V/m with an accuracy of ± 1 V/m with half-hourly calibrations. The response time is about one-tenth second. The theory of their operation is given, including an analysis of the disturbing effects of rain and air-earth currents, and of grid current in the first valve of the amplifier. The limitations to their accuracy are discussed and improvements in design are suggested. A review of earlier field mills and other "mechanical collectors" is included. A.

550.383.3 : 532.51 : 538.56 : 523.75

Hydromagnetic dynamo models. *See Abstr.* 9372

550.385 : 537.591.5

On the correlation between geomagnetic activity and the diurnal variation of cosmic rays. *See Abstr.* 9749

550.385.41 : 523.75

Solar prominences and geomagnetic disturbance. *See Abstr.* 9373

550.387

10099. Apparent terrestrial magnetic local inhomogeneities of electrical conductivity in the lower strata. J. Bartels. *Nachr. Akad. Wiss. Göttingen, Math.-Phys. Kl. IIa*, **1954**, *No.* 5, 95–100. In German.

The various observations in Germany, America and Australia on the electrical conductivity near the earth's surface are reviewed. Secular variations of the order of hundreds of years are attributed to the earth's core, and short-period changes of the order of 11 years to a few secs to induction. Vacquier's results are considered to be due to local air circulations in the ionosphere. In and near the auroral zone rapid variations of Z, H and D occur. As the distance away increases the ionospheric current acts more on H and D, but the auroral current on Z. At still greater distances there is a more homogeneous current in the ionosphere. The earth current is considered to be a secondary effect due to electromagnetic induction by temporary oscillations of the primary ionospheric systems. The local earth current gradient at the surface could be the integrated effect of the total earth flow as in magnetic variations. During the International Geophysical Year conductivity anomalies and earth current registrations will be made with a portable magnetograph for systematic ground measurements with a wide network of earth magnetic observatories to examine the subject further.

R. S. READ

550.387

10100. Model for induced terrestrial magnetic electric current in lower strata. W. Kertz. *Nachr. Akad. Wiss. Göttingen, Math.-Phys. Kl. IIa*, **1954**, *No.* 5, 101–10. In German.

A method for analysis of the magnetic field observed on the earth's surface due to causes lying inside or outside the earth is applied to Bay-disturbances for Mid and N. Europe. The inner part indicates a field at 80 km depth with westward line flow over N. Germany as in Fleicher's results. Equations are set up and solved to find whether a stream distribution at other depths can act and suffice for the current density of a horizontal surface flow in the lower layers and produce the given magnetic field at the surface. The surface current which in a thin layer would flow like the given line current, and would produce the same magnetic field at the surface, is also calculated. For greater depths such an equivalent current distribution is not obtained. It is next shown how to approximate from greater depths to the linear current by the magnetic field of a plane surface current. This current distribution is very complicated and improbable in nature. Finally, a model is set up of the horizontal surface current, with given current density, which in small depths flows as the given line current and whose magnetic field can be approximated by the field of the line flow. R. S. READ

550.93 : 537.542

10101. Liquid scintillation techniques for radiocarbon dating. R. W. Pringle, W. Turchinetz and B. L. Funt. *Rev. sci. Instrum.*, **26**, *No.* 9, 859–65 (*Sept.*, 1955).

A study has been made of the merits of liquid scintillation methods for radiocarbon dating. The synthesis of toluene from sample carbon, and the use of this liquid in a 20 cm^3 cell, in combination with the best available photomultiplier tube, gave results which indicate that this method can be of significance for samples of age 45 000 years, for a 48 hr counting period. A background counting rate of 3·34 c.p.m. was obtained with "old" toluene and adequate shielding and pulse-height discrimination, but without photomultiplier cooling or the use of coincidence-anticoincidence arrangements. This method suffers, however, from a rather elaborate chemical synthesis, so that a simpler diluent technique was studied, involving the synthesis of methanol from sample carbon. This method is suitable for routine analysis, and gave results indicating a significance to 37 000 years, the decreased accuracy of the method being the result of the somewhat lower fluorescence efficiency of the scintillating mixture. There is evidence that a routine methyl borate diluent method will give an accuracy comparable to that of the toluene method. A.

ATMOSPHERE . METEOROLOGY 551.5

551.501.7

10102. Methods for the measurement of upper atmospheric characteristics. S. N. Ghosh. *J. sci. industr. Res.*, **14A**, *No.* 6, 277–84 (*June*, 1955).

A review of methods used. Indirect methods with ground-based apparatus may apply the probe method as in wind velocity by gunfire, radar study of meteors, anomalous propagation of sound, and the use of searchlight beams for air density and temperature. Natural phenomena are used for the spectra and intensity of aurorae, and the height of appearance and disappearance of meteors. In direct methods instruments are carried into the layers by balloons or rockets. Day and night air-glow may be deter-

mined by the Van Rhijn method, and ionospheric research into electron density and the fine structure of the ionized layer. Laboratory methods can be combined with theory to investigate collision processes, the recombination coefficients in ionized layers, and to determine photochemical reactions and absorption coefficients, examples of which are given. R. S. READ

551.508.71

10103. Positive point discharge as a hygrometer of small inertia. N. E. ANDERSSON AND C. H. HERTZ. *Z. angew. Phys.*, **7**, *No.* 8, 361–6 (1955) In German.

Describes the design and the performance of a hygrometer which depends for its operation on a positive point-to-plane discharge system in which the number of filamentary discharges per second varies with the humidity. This hygrometer is particularly useful for transpiration measurements in plant physiology because of its fast response to changes in humidity and low air consumption. J. DUTTON

551.508.91

10104. Study, by electric analogue, of the thermal field in the interior of a thermal precipitator. E. BRUN, J. LEROUX AND P. MARTY. *J. Rech. Cent. Nat. Rech. Sci.*, **6**, 256–9 (*June*, 1955) In French.

An investigation of whether the replacement of the glass collecting plates by electron-microscope specimen holders affects the thermal field. It is concluded that the wires supporting the film have a pronounced effect on the thermal field and invalidate the assumption that a representative sample of the dust has been obtained. J. M. HOUGH

551.508.96

10105. Measurement of ionospheric heights by the method of delayed coincidence. H. RAKSHIT AND S. D. CHATTERJEE. *Z. Phys.*, **141**, *No.* 5, 540–9 (1955).

A precision method of ionospheric height measurement is described. It utilizes the method of coincidence as used in the study of delayed nuclear reactions. The accuracy attained was much higher than has hitherto been possible. At the present stage of development it was $\pm 0{\cdot}1$ km, but with further refinements in the circuits it is possible to improve upon this. It is expected that the technique will be found very useful in studying small variations in height such as for studying the fine structure of the ionosphere, the tidal effects and similar cases. A.

551.510

10106. Diffusion processes in the thermosphere. P. MANGE. *Ann. Géophys.*, **11**, *No.* 2, 153–68 (1955).

The present applications of particle diffusion theory in aeronomy are delineated. Some of the earlier contributions of other authors to the theory are indicated as the present applications are examined. In general, the previous discussions of diffusion which have assumed an isothermal model atmosphere are adapted to a model atmosphere with temperature varying linearly with altitude. The present survey includes considerations of (1) possible steady-state diffusion equilibrium distributions; (2) the rapidity of minor constituent redistribution from mixing distributions by diffusive action and (3) the problem of the distribution of molecular oxygen above 100 km as an example of diffusion in a region in which sources and sinks exist. The nature of the influence of constituent molecular mass, basic constituent flow and thermal diffusion on the steady-state constituent distribution is shown. The rapidity of minor constituent diffusion is worked out for a variety of constituents in the non-isothermal atmosphere. The simultaneous influences of photochemical action, mixing and diffusion in determining the oxygen distribution are analysed by considering diffusion from an initial photochemical, rather than mixing, distribution. A.

551.510 : 523.5

10107. Upper atmospheric data from meteors. T. R. KAISER AND S. EVANS. *Ann. Géophys.*, **11**, *No.* 2, 148–52 (1955).

Recent upper atmospheric data deduced from radio-echo observations of meteors are compared with those obtained by other techniques. A.

551.510.5

10108. Rocket data on atmospheric pressure, temperature, density, and winds. H. E. NEWELL, JR. *Ann. Géophys.*, **11**, *No.* 2, 115–44 (1955).

The following subjects are covered: rocket upper air research in the United States; the basic measurements; Naval Research Laboratory measurements related to atmospheric structure (atmospheric pressures, atmospheric densities at White Sands, atmospheric pressures and densities above the equator, atmospheric pressures and densities in northern latitudes, measurements of pressure by X-rays, atmospheric temperature, heating by atmospheric ozone, winds); Signal Corps measurements of atmospheric temperatures, densities and winds (the rocket grenade experiment, the falling sphere experiment, the shock-wave angle experiment); Air Force experiments to determine atmospheric structure. A.

550.510.535

10109. The vertical distributions of the temperature and density in the lower ionosphere. Y. INOUE. *Mem. Coll. Sci. Univ. Kyoto A*, **27**, *No.* 2, 67–99 (*July*, 1954).

Some results obtained were: (i) there occur a steep temperature gradient and an almost abrupt decrease of the particle concentration of molecular oxygen in the E region; (ii) the theoretical possibility of the existence of the particle concentrations sufficient to account for the generation of the $F1$ and $F2$ layers has been shown. It must be remarked that the theoretical pressure distribution is not in agreement with that of the ambient pressure measured during rocket flights. Problems of the $F2$ region related to the present problem are discussed briefly. Also, the effect of thermal conduction is examined. A.

550.510.535

10110. On anomalous variations of maximum electron density and its height in the $F2$ region of the ionosphere. T. SATO. *J. Geomagn. Geoelect.*, **6**, *No.* 3, 99–119 (*Sept.*, 1954).

550.510.535

10111. Investigation of vertical movements of the $F2$ layer. N. V. GURUNADHA SARMA. Letter in *Curr. Sci.*, **24**, *No.* 6, 190–1 (*June*, 1955).

Periodic fading of short-wave signals in the early morning and late evening, attributed to interference

of singly reflected waves from the E and $F2$ layers when these have vertical movements, has been studied. Separate simultaneous medium-wave records yield the lifting velocities for the E layer and measurements of the fading frequency then give the $F2$ layer velocities. Results for three evenings in Oct., 1953, indicate that velocities are definitely greater for the $F2$ layer (mean 3·4 m/s) than for the E layer (mean 2·3 m/s). G. M. BROWN

551.510.535

10112. The effect of vertical ion transport on the night-time *E*-region. H. R. PEIFFER AND A. P. MITRA. *J. atmos. terrest. Phys.*, **6**, *No.* 6, 291–303 (*June*, 1955).

Considers the effect of vertical ion transport on the ionization distribution of the night-time E region. The nature and magnitude of the tidal velocities and of the recombination coefficient, which enter into the calculations, are obtained from various sources, both experimental and theoretical. It is shown that vertical ion transport is of importance in the night-time E region and that this factor is capable of explaining certain heretofore anomalous experimental observations pertaining to the night-time E layer. A.

551.510.535

10113. Hydromagnetic resonance in ionospheric waves. C. O. HINES. *J. atmos. terrest. Phys.*, **7**, *No.* 1–2, 14–30 (*Aug.*, 1955).

The characteristics of one class of travelling ionospheric disturbance may be partially explained as the result of an observational selection, in which an atmospheric wave provides the basic disturbance and a hydromagnetic resonance the selection. This resonance occurs when natural modes of electromagnetic oscillation are generated through hydromagnetic coupling with the atmosphere, and it results in an enhanced motion of the ionospheric electrons which are alone observable. The quantitative comparison with observation provides estimates for the specific heat ratio ($\gamma \sim 1{\cdot}1$) and scale height ($C^2/\gamma g \sim 20$ km), which are lower than the values expected for the $F2$ region concerned, but which are nevertheless possible and certainly valid in order of magnitude. A.

551.510.535

Radio-wave propagation in the ionosphere. *See also under* "Electromagnetic waves and oscillations." Decimal classification 538.566.3

551.510.535 : 550.384

10114. Geomagnetic distortion of the *F2* region on the magnetic equator. M. HIRONO AND H. MAEDA. *J. Geomagn. Geoelect.*, **6**, *No.* 3, 127–44 (*Sept.*, 1954).

The direct relation between the geomagnetic S_q variation and the vertical electron drift in the $F2$ region on the magnetic equator is examined. It is shown that the electric field in the $F2$ region accompanied by S_q electric current produces vertical drift, which is sufficient to interpret the main features of the anomaly of the $F2$ region on the equator. It is to be noticed that the main term of the drift velocity is diurnal. The daily variations of the maximum electron density and its height in the $F2$ region are calculated under consideration of the vertical electron drift for the reasonable distribution of decay coefficient with altitude inferred by observed results. The calculated $F2$ daily variations have a striking resemblance to those observed near the magnetic equator. When the ion production takes its maximum value at about 200 km, there appears a lower secondary maximum of electron density which agrees well with the observed $F1$ layer. The change of characteristics of daily variations of the $F2$ region with the sunspot-cycle is likely to be accounted for by a slight shift of the phase of the drift. A.

551.510.535 : 550.385

10115. Studies on the disturbances in *F2* layer associated with geomagnetic disturbances. K. SINNO. *J. Geomagn. Geoelect.*, **6**, *No.* 3, 120–6 (*Sept.*, 1954).

The separation of variations in f^0F2 and $h'F2$ associated with geomagnetic storms into two parts, depending on the universal time and local time, the so-called $Dst(F2)$ and $S_D(F2)$, respectively, was clarified. The development process of the $F2$ disturbance was investigated in respect to $D_{st}(F2)$ and $S_D(F2)$. It is concluded that $S_D(f^0F2)$ exists in the earlier stages of a geomagnetic storm and $D_{st}(f^0F2)$ grows in a comparatively later stage. The latitudinal and seasonal characteristics were shown. Investigations were made in the behaviour of the $F2$ layer according to the different levels of geomagnetic activities. Results showed that the $F2$ layer disturbance was generally in proportion to the geomagnetic activities, except for $D_{st}(f^0F2)$ variation in winter. As to the successive yearly variation of ionospheric disturbance, it was found that the phase of $S_D(F2)$ lagged behind according to the decrease of sunspot activity. A.

551.510.535 : 550.385

10116. Geomagnetic activity and average deviations of daytime F_2-layer critical frequencies in different geomagnetic latitudes. G. LANGE-HESSE. *J. atmos. terrest. Phys.*, **7**, *No.* 1–2, 49–60 (*Aug.*, 1955) In German.

The observational data of six ionospheric stations and one geomagnetic observatory are systematically analysed in order to find out statistical relations between the degree of geomagnetic activity and the average deviations of the daytime $F2$ layer critical frequencies from their median values. The observational data are arranged only according to the degree of geomagnetic activity; then the average deviations are determined for different degrees of geomagnetic activity. There appears a distinct dependence on the geomagnetic latitude, the seasons, and the sunspot cycle. The practical significance of these results for the prediction of ionospheric disturbances is discussed. Figures are given representing the reliability of these predictions for different geomagnetic latitudes, different seasons and phases of sunspot cycle. A.

551.510.535 : 551.501.8

10117. A note on factors affecting the interpretation of observations of transient echoes from the ionosphere. C. A. SHAIN AND F. J. KERR. Note in *J. atmos. terrest. Phys.*, **6**, *No.* 5, 280–1 (*May*, 1955).

It is pointed out that variations in the intensity of cosmic radio noise have an important effect on the observed rate of occurrence of transient echoes received on high-powered radars from scattering centres just below 100 km. Allowance for this in one

particular case removes the previously unexplained midday maximum in the rate of occurrence of these echoes, although the peak at 0500 hr, coinciding with the maximum rate of occurrence of sporadic meteors, remains. It should also be possible to determine whether the height of the increased absorption during S.I.Ds. is above or below the transient echo region. An apparent grouping of the echoes in time is not found to be statistically significant.

G. M. BROWN

551.513

10118. The lunar air tide. R. SAWADA AND B. HAURWITZ. *Ann. Géophys.*, **11**, *No.* 2, 145–7 (1955).

The lunar air tide, especially its surface pressure oscillation has been computed for various vertical temperatures profiles and has been analysed with regard to the atmosphere behaviour. A.

551.513 : 551.594.14

10119. Unusual radioactivity observed in the atmospherical precipitation in Debrecen (Hungary) between Apr. 22–Dec. 31, 1952. A. SZALAY AND D. BERÉNYI. *Acta phys. Hungar.*, **5**, *No.* 1, 1–14 (1955).

The authors investigated, by means of an end-window β-counter tube equipment the activity of precipitation fallen in Debrecen between April 22 and December 31, 1952. At times the precipitations showed radioactivity, which proved to be due to fission products deriving from atomic explosions. These anomalous activities, with a lag of a few days, were in correlation of time with the atomic explosions published during the same period. The order of magnitude of the activity calculated for a precipitation of an area of 1/50 sq metres was 10^{-11} Curie. Calculating this figure to the whole surface of earth it appears obvious that this activity refers to the average value of activity of the whole surface or possibly of the northern hemisphere of the earth rather than to the activity of air masses incidentally drifted here. It appears from the investigations that by using an equipment of adequate sensitivity the fission products of an atomic bomb may be registered even at very considerable distances. The authors are of the opinion that by systematic and internationally organized observations of air masses to which activity had been imparted by way of atomic explosions or in any other way, the problems of general circulation, the movement of air masses and their interchange between the two hemispheres could be most efficiently studied and thereby the solution of the most recent problems of meteorology approached. A.

551.521.3

10120. Illuminance and luminance under overcast skies. S. FRITZ. *J. Opt. Soc. Amer.*, **45**, *No.* 10, 820–5 (*Oct.*, 1955).

The illuminance of a horizontal surface at the ground below an overcast sky is computed. The transmittance, T, of visible light is given as a function of the cloud optical thickness, h/L, of the sun's zenith distance, Z, and of the reflectance, a, of the underlying surface. For some cloud thicknesses, T varies markedly with Z. Also, for thick clouds, T is several times larger over a fresh snow cover than it is over snow-free ground. A formula for luminance distribution, $B(\theta)$, of a heavily overcast sky is presented. This formula agrees fairly well with existing measurements made over snow-free terrain; however, it further suggests that $B(\theta)$ will become much more uniform when a fresh snowfall uniformly covers the ground.

A.

551.521.326

10121. A review of observational results in airglow photometry. F. E. ROACH. *Ann. Géophys.*, **11**, *No.* 2, 214–31 (1955).

Subjects covered are: the nature of the nightglow; the diurnal variation; the seasonal variation; correlations with sunspot and magnetic activity; the height of the nightglow; suggestions for the International Geophysical Year. A.

551.521.326

10122. Theories of the airglow spectrum. M. J. SEATON. *Ann. Géophys.*, **11**, *No.* 2, 232–48 (1955).

Certain salient observational results are summarized. The problem of the heights of the emitting layers is discussed and it is concluded that, with the possible exception of the [O I] red lines, it is difficult to accept that the emission heights could be appreciably greater than 100 km. For OH, Na and O_2 atmospheric band heights appreciably less than 100 km seem by far the most plausible. The following theories are discussed: (1) chemical energy sources (molecular recombination following photo-dissociation); (2) recombination of charged particles in the ionized layers; (3) excitation by incoming particles; (4) conversion of atmospheric kinetic energy to radiant energy. It is concluded that theory (1) is by far the most plausible but that theory (2) may account for at least part of the [O I] red line intensity. It is considered that, for small solar depression angles, the twilight enhancement of the [O I] red lines is mainly due to resonance, but that other processes are responsible for the enhancement at larger depression angles. It is considered improbable that the twilight emission of [N I] λ5199 is due to resonant excitation. Over 70 refs. A.

551.593.9 : 537.591

10123. Light pulses from the night sky and Čerenkov radiation. II. J. V. JELLEY AND W. GALBRAITH. *J. atmos. terrest. Phys.*, **6**, *No.* 6, 304–12 (*June*, 1955).

For Pt I, see Abstr. 6653 (1955). Further experiments on the Cherenkov radiation produced by extensive air showers in the atmosphere are described. The integral pulse-height distribution of the light pulses is found to fit closely a power law. The variation in rate of firing of a Geiger counter falls off slowly with distance from the light-receiver. Although the pulse-height distribution is a broad one, it is found that, in general, the larger light pulses are associated with the higher energy showers. The variation in pulse rate with zenith and azimuth angle of a light-receiver has been studied, and the receivers have been used for searching areas of sky for possible point sources of cosmic radiation. A.

551.594

10124. An experimental problem in the atmospheric-electrical synopsis. The separation of conduction current and Maxwell's displacement current in measurements of the air-earth current. H. ISRAËL. *J. atmos. terrest. Phys.*, **6**, *No.* 6, 322–7 (*June*, 1955).

In order to separate the different influences causing the atmospheric-electrical variations, a synoptical

method of research has been applied. The measurement of the air-earth current, needed in this method, is commonly disturbed by the variations of the atmospheric-electrical field which produce a displacement current in the "antenna." This difficulty can be avoided by an arrangement proposed by H. W. Kasemir, which enables one to separate the displacement current and the conduction current. The "method of adaptation" is described. A few examples show that by employing this method all variations of the air-earth current can be measured correctly. A.

551.594.12

10125. Intermediate and large atmospheric ions at Cairo–Giza. G. Ortner and Abdel Fattah el Nadi. *J. atmos. terrest. Phys.*, **7**, *No.* 1–2, 31–48 (*Aug.*, 1955).

The mobility spectrum of atmospheric ions in the mobility range below 100×10^{-4} cm^2/volt. sec has been investigated, using types of the cylindrical condenser method. Distinct ion groups with definite values of the mobilities have been found (discontinuous spectrum). The mobilities in the range between (10 and 100)$\times10^{-4}$ cm^2/volt.sec change from day to day, but are fairly constant in the range below 10×10^{-4} cm^2/volt.sec. A certain influence of visible light on the ion concentration was observed. A.

551.594.14

10126. Self-purification of the atmosphere. O. Haxel and G. Schumann. *Z. Phys.*, **142**, *No.* 2, 127–32 (1955) In German.

Natural radioactivity leads to the presence of solid atoms produced from emanations in aerosols; these atoms tend to be removed from the aerosol by various natural processes and hence the various decay products are not in equilibrium. Investigations on the decay products of radon have been made both theoretically and experimentally leading to a "half-life" for atmospheric purification of days. Studies of the fission products of atom bombs show a much greater half-life for purification owing to the absence of condensation nuclei in the stratosphere. J. M. Hough

551.594.14

10127. Diurnal variations in natural atmospheric radioactivity. E. S. Cotton. *J. atmos. terrest. Phys.*, **7**, *No.* 1–2, 90–8 (*Aug.*, 1955).

The diffusion of radium emanation in the atmosphere is considered, using several simplifying assumptions in order to gain an understanding of diurnal changes in the concentration within the surface layer. The order of magnitude of the night-to-day ratio for various daytime concentrations is calculated and compared with continuous ionization records made during the 1952 and 1953 autumn seasons. The importance of meteorological factors is pointed out and typical records shown. A.

551.594.5

10128. The location and shape of the auroral zone. J. H. Meek. *J. atmos. terrest. Phys.*, **6**, *No.* 6, 313–21 (*June*, 1955).

Variations of the earth's magnetic field have been examined, using data of the Polar Year 1932–33. It is concluded that the auroral zone takes the form of two opposing Störmer-like spirals, one due to positive-particle precipitation and the other due to negative-particle precipitation. These spirals intersect each other at a high latitude at about 10 a.m. local geomagnetic time, and at a lower latitude at about 10 p.m., and move around the earth with the sun. It is proposed that the disturbance-particle stream coming from the sun is not necessarily continuous or uniform. As it passes the earth, charged particles are ejected from it and follow Störmer trajectories into the auroral zone, resulting in the observed auroral light displays and magnetic disturbances. Some of the observed characteristics of aurora are discussed in view of this proposal. A.

551.594.5 : 551.510.535

10129. The auroral *E*-layer ionization and the auroral luminosity. A. Omholt. *J. atmos. terrest. Phys.*, **7**, *No.* 1–2, 73–9 (*Aug.*, 1955).

The photon emission within the negative nitrogen bands emitted from aurorae in zenith and the maximum electron density in the *E*-layer are measured simultaneously. A correlation is found between these two quantities. From the observations the recombination coefficient in the *E*-layer during aurorae is found to be greater than 10^{-7} cm^3.sec^{-1}. In medium to strong aurorae the mean electron density is found to be 2 to 10×10^5 electrons.cm^{-3}. The radio echoes in the v.h.f. band during aurorae are briefly discussed. A.

551.594.51

10130. On the measurement of rotational temperature from unresolved auroral nitrogen bands. G. G. Shepherd and D. M. Hunten. *J. atmos. terrest. Phys.*, **6**, *No.* 6, 328–35 (*June*, 1955).

It is pointed out that the intensity of an unresolved profile depends not only on the intensity of the lines but also on their spacing. Neglect of the correction for spacing can give rotational temperatures too low by 40° at 250°K and 400° at 1 000°K when the 3 914 Å band of N_2^+ is used. 180 temperature measurements have been made on aurora, and fifteen are accompanied by measured heights. Although the observations cover too small a height-range to be conclusive, both the variation of temperature with height and the variation with type of aurora appear to agree with the generally accepted temperature gradient in the auroral region. A.

551.594.51

10131. Rotational temperatures in the auroral N_2^+ bands. A. V. Jones and A. W. Harrison. *J. atmos. terrest. Phys.*, **6**, *No.* 6, 336–43 (*June*, 1955).

A series of auroral spectra in which the 0–0 N_2^+ band is completely resolved, have been obtained at Saskatoon. Analysis of the plots of log I/K' against $K'(K'+1)$ for intensity distribution of the rotational fine structure lead to temperatures ranging from 250° to 400°K. Some of the plots exhibit a curvature which had been interpreted as arising from a variation of temperature with height through the auroral region. The conclusions reached have been tested by obtaining spectra from a laboratory source of the N_2^+ bands. A.

551.594.6

10132. Some waveforms of atmospherics and their use in the location of thunderstorms. F. Horner and C. Clarke. *J. atmos. terrest. Phys.*, **7**, *No.* 1–2, 1–13 (*Aug.*, 1955).

Illustrations are given of the main types of wave-

forms which have been recorded in southern England, using equipment previously described. Particular emphasis is given to echo-type waveforms comprising a series of echoes arriving by different modes of reflection between the earth and the ionosphere. Practical difficulties arising in the use of this type for estimating the distance of the source are discussed. The range is estimated from the measurement of the time-intervals between echoes, which under good conditions may be determined to an accuracy of 2μsec. Waveforms usually show discrepancies considerably greater than this figure when the time-intervals are compared with what would be expected from simple reflection theory and a graphical method of analysis is used which averages the errors on individual echoes. The effect of these discrepancies on the accuracy of distance estimation is discussed. The frequency of occurrence of suitable types of waveform is derived from an analysis of routine recordings over a period of one year. Approximately 3% of the waveforms recorded in daylight and 5% at night were suitable for deriving an estimate of distance, but more detailed analysis of a proportion of the waveforms indicated that by changes in technique, the night-time figure might have been increased by a factor of about 2. With experience it is not difficult to select by cursory inspection those waveforms which are likely, on analysis, to yield a useful distance estimate. Many of them, however, are rather complex, and considerable time is required to determine from these the most probable value of distance. Most night-time storms within 2000 km give rise to some waveforms from which a reliable distance estimate can be deduced; by day the corresponding range is about 500 km in summer and 1000 km in winter. Within these ranges errors can be expected to be within $\pm 30\%$. It is concluded that waveform analysis would be of some value for thunderstorm location as an adjunct to a network of cathode-ray direction finders, but that the reliability and convenience of the technique are not yet sufficient for use as the sole method of estimating distance. A.

551.596.1

10133. The attenuation of sound in a turbulent atmosphere over a desert terrain. M. Mokhtar and M. A. Mahrous. *Acustica*, **5**, *No.* 3, 179–81 (1955).

The effect of atmospheric turbulence on the overall sound intensity received downwind of a source at different distances from it and at various heights above the ground was investigated. The results revealed the occurrence of a zone of maximum intensity followed by another of minimum intensity at a higher level. The effect of "eddies" formed in the turbulent atmosphere on the diffraction pattern of the source was studied. A.

BIOLOGY 57/59

578 : 539.166.08

An apparatus for the measurement of γ-radiation from the human body. *See Abstr.* 9884

578.088.5

10134. The relative biologic effects of X-rays and beta rays. W. B. Seaman, M. M. Ter-Pogossian and W. B. Ittner, III. *Radiology*, **65**, *No.* 2, 260–4 (*Aug.*, 1955).

The relative biologic efficiency of 200 kV X-rays and the β-rays of P^{32} in producing erythema on a rabbit's ear was studied. With equal doses and similar physical distribution in tissue, the β-rays of P^{32} were found to be slightly less than one-half as efficient. A.

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.843 : 621.397.8

10135. The human eye in relation to the television picture. G. A. Boutry. *Optica Acta*, **2**, *No.* 2, 81–101 (*July*, 1955) In French.

A study of the behaviour of the normal human observer when examining a television display under conditions approximating those of home entertainment. Special attention is given to the case of colour television and experiments are described by the aid of which it has been found possible to estimate the amount of colour pollution and "diaphoty" permissible; the variation of the resolving power of the eye with colour, the visibility of flicker and of moving structures superimposed on the significant image are also investigated. A.

612.843.371

10136. Infrared photography of the so-called third Purkinje image. J. W. Wulfeck. *J. Opt. Soc. Amer.*, **45**, *No.* 11, 928–30 (*Nov.*, 1955).

A brief history of the significance of the 1st and 2nd lens reflexes in physiological optics is presented and the development of photographic techniques for recording the lens reflexes is outlined. A new technique for photographing the 1st lens reflex under infrared, and hence extra-visible, illumination is detailed. A.

612.843.5

10137. Effect of reference lines on the discrimination of movement. H. Leibowitz. *J. Opt. Soc. Amer.*, **45**, *No.* 10, 829–30 (*Oct.*, 1955).

The minimum discriminable target velocity was determined with and without reference lines in the visual field. At a short (0·125 sec) exposure duration, where velocity discrimination is determined primarily by the magnitude of initial photochemical events, the velocity threshold is not changed by the introduction of reference lines. At a long (16 sec) exposure duration, the presence of reference lines lowers the threshold velocity by 48%. The data are interpreted as supporting the hypothesis that movement is discriminated at slow speeds by observation of change of position. A.

612.843.6

10138. Critical duration in visual brightness discrimination for retinal areas of various sizes. W. R. BIERSDORF. *J. Opt. Soc. Amer.*, **45**, *No.* 11, 920–5 (*Nov.*, 1955).

Visual brightness discrimination was investigated for three centrally fixated incremental areas (1° 20′, 5° and 19°) each superimposed upon a 26° surround. Surround luminances from $\log I = 3{\cdot}48$ to $\log I = -3{\cdot}02$ (millilamberts) were used. The objectives of the experiment were to find: (*a*) the shape of the transition between the two theoretical conditions It = constant and I = constant as the duration of incremental exposure was increased, and (*b*) the magnitudes of the critical durations at which this transition occurred. The results indicated that the transition between conditions It = constant for central fixation was relatively sharp, regardless of field size or luminance level. This was true for both differential and absolute threshold determinations. The critical durations, depending upon field size, ranged from 0·02–0·06 sec at high luminances to as long as 0·20–0·35 sec at low scotopic luminance levels. The curves relating critical duration to log luminance showed irregularities in the mesopic range for the two larger fields. These irregularities were interpreted as indicating a possible transition between rod and cone functioning in this luminance range. A.

612.843.611

10139. Some direct comparisons between light and dark adaptation. H. D. BAKER. *J. Opt. Soc. Amer.*, **45**, *No.* 10, 839–44 (*Oct.*, 1955).

Both the absolute threshold and the difference threshold appear to be limited by photochemical conditions in the visual receptor during dark adaptation, and after complete light adaptation to any luminance level. During light adaptation the absolute threshold reflects photochemical conditions but the difference threshold does not. It is suggested that this is because the difference threshold is affected by the near-maximum response of the visual receptor during early light adaptation. Experiments which test this idea are reported. A.

612.843.613

10140. Effect of differential adaptation of the eyes upon threshold sensitivity. R. T. MITCHELL AND L. H. LIAUDANSKY. *J. Opt. Soc. Amer.*, **45**, *No.* 10, 831–4 (*Oct.*, 1955).

Experimental determination was made of the effect of intense light-adaptation (6·20 log trolands) of one eye upon the dark-adapted threshold of the other eye. A psychophysical method derived from Békésy and analogous to the "up and down" method of Dixon and Mood was used. Three subjects showed a slight increase in sensitivity; one showed no change. The change was not statistically significant for the group. The finding is consistent with the accepted view that the states of adaptation of the eyes are independent and in contradiction to studies which have found an averaging effect. A.

612.843.613

10141. Absolute threshold and frequency-of-seeing curves. M. H. PIRENNE AND F. H. C. MARRIOTT. *J. Opt. Soc. Amer.*, **45**, *No.* 11, 909–12 (*Nov.*, 1955).

The simplest interpretation of the uncertainty of seeing observed at the absolute threshold is based on the theory of quantum fluctuations and assumes that in any given trial the light is seen when the retina has been acted upon by at least n quanta. When this assumption is true the frequency-of-seeing curve is a simple Poisson sum of parameter n, and the "mean threshold intensity," that is the mean number of quanta I (55%) acting on the retina for a frequency of seeing of 55%, is very nearly equal to n. Biological variations of n would make the curve shallower than it would be if n were constant and approximately equal to the "mean threshold intensity," I (55%). The same result is valid in the case of all other complications which might occur with regard to the physiological mechanisms involved, and which would make the simplest interpretation invalid. Thus the slope of experimental curves obtained under suitable conditions must be smaller than or equal to the slope of a simple Poisson sum the parameter of which is approximately equal to the "mean threshold intensity." From the slope of such curves, therefore, it is always possible to derive a lower value for the "mean threshold intensity." A.

612.843.614

10142. Studies on the brightness discrimination. I. Measurement of Fechner fraction. K. KUBO. *J. Sci. Res. Inst* [*Tokyo*] **49**, 46–60 (*March*, 1955).

The Fechner fraction as a function of retinal illuminance was measured by a statical observing method with white, red, green and blue lights. The effect of the surrounding field on the observed value was investigated, together with the effect of colour in comparison field. The effect of luminance variation is considerable and systematic, whereas that of colour variation is insignificant. Empirical formulae representing this effect are obtained. A.

612.843.614

10143. Studies on the brightness discrimination. II. On the value function. K. KUBO. *J. Sci. Res. Inst.* [*Tokyo*] **49**, 61–72 (*March*, 1955).

The value scales from zero to 20 are determined for white light against retinal illuminance range of $0 \sim 1\,000$ trolands using the observed values of $\Delta B/B$ previously reported. Then a new value function for white light is theoretically derived on the basis of photochemical reactions in the photo-receptor cell. The effect of colour of the test field is discussed as due to different values of the reaction constants, and the effect of luminance of the surrounding field as due to the difference between measurable and true retinal illuminances. A.

612.843.614

10144. Studies on the brightness discrimination. III. Measurement of the Fechner fraction by flickering method. K. KUBO. *J. Sci. Res. Inst.* [*Tokyo*] **49**, 73–84 (*March*, 1955).

The results are compared with those obtained by the statical method (Pt I). Intrinsic difference between the two methods is ascertained. Optimum flicker frequency used in the photometry was measured in relation to the retinal illuminance. This relation is roughly explained on the assumption that the visual sensation is of exponential type and its additivity holds. The results are treated not as photochemical

but rather as analogous to electric transient phenomena. A.

612.843.614

10145. Studies on the brightness discrimination. IV. On the critical frequency. K. KUBO. *J. Sci. Res. Inst.* [*Tokyo*] **49,** 85–96 (*March*, 1955).

Critical and optimum flicker frequency as functions of retinal illuminance were measured for white light with various light/dark ratios (p) of flicker. Relation between the logarithms of the flicker frequency and the retinal illuminance is found to consist of a linear part in the Fechner range and the remaining curved part in glare range with a maximum which shifts horizontally as p changes. The magnitude of this shift cannot be given by Talbot–Plateau law. Theoretical explanation of the linearity is extended to any p other than 1/2 on the assumption that the visual initiation and the after-effect are both represented by an exponential function of time. The validity of this assumption is significant in physiological optics. A.

612.843.63

10146. Refinement of checkerboard targets for measurement of visual acuity limens. A. MORRIS, M. S. KATZ AND J. D. BOWEN. *J. Opt. Soc. Amer.*, **45,** *No.* 10, 834–8 (*Oct.*, 1955).

Checkerboard targets to be used in the precise measurement of visual acuity have been validated with the aid of a χ-square statistic. Secondary cues which lead to spurious data have been eliminated in some targets by using a black border, and accurate acuity measurements were obtained. For the given conditions the interchangeability of varying visual angle in small ranges was established (*a*) by changing target size and (*b*) by changing target distance. The range of stimuli required to establish an acuity limen is approximately 12 sec of visual angle. A.

612.843.72

10147. Commonplace viewing and depth discrimination. W. H. TEICHNER, J. L. KOBRICK AND E. R. DUSEK. *J. Opt. Soc. Amer.*, **45,** *No.* 11, 913–20 (*Nov.*, 1955).

Measures of commonplace depth discrimination were obtained at observation distances of 200, 750 and 1 500 feet in an Arctic area over flat terrain. Comparisons were made with similar measures taken over four different kinds of terrain (including an airstrip) in a desert area and with similar data reported by other investigators. The results indicate that within a range of 100 to 3 000 feet the standard deviation (precision) of depth discrimination is related to observation distance (D) approximately as the function, $D^{1.35}$. Within the same range the associated binocular image disparity decreases approximately as $D^{-0.65}$. It is suggested that for commonplace viewing the angle of disparity is better conceived of as a measure of relative depth acuity rather than of stereoscopic acuity. The results also suggest that under the conditions studied commonplace depth acuity is 95–100% finer than stereoscopic acuity alone, binocular acuity is only slightly, if at all, superior to monocular acuity, and that the qualities of the terrain such as its texture have little or no effect. It was concluded that stereoscopic vision makes only a slight contribution to the precision of depth discrimination although it may be very important in producing a feeling or effect of depth. The hypothesis was put forth that vernier acuity is the major basis for commonplace depth discrimination. A.

612.843.721

10148. Instrument for the study of binocular vision. G. S. HARKER. *J. Opt. Soc. Amer.*, **45,** *No.* 10, 826–8 (*Oct.*, 1955).

The engineering details of a laboratory apparatus for the precise measurement of angles of vergence in binocular vision are presented, and problems of calibration and possible uses are discussed. A.

612.843.721 : 612.845.1

10149. Night binocular convergence and night myopia. A. IVANOFF. Letter in *J. Opt. Soc. Amer.*, **45,** *No.* 9, 769–70 (*Sept.*, 1955).

Convergence measurements were made on 7 observers at luminance levels ranging from 10^{-6} to 1 c/m^2, and accommodation measurements between total darkness and 10^{-3} c/m^2. It is concluded that night myopia is mainly due to binocular night convergence. R. A. WEALE

612.844.24

10150. Accommodative response of the eye of an aged cat to electrical stimulation of the ciliary ganglion. E. MARG AND J. L. REEVES. *J. Opt. Soc. Amer.*, **45,** *No.* 11, 926–8 (*Nov.*, 1955).

A fifteen-year-old cat was studied in a manner similar to and compared with a previous study on a series of young cats. The ciliary ganglion was stimulated electrically with various voltages and frequencies. Accommodative response of the eye to this electrical stimulation was measured with a Rodenstock Eye-Refractometer. No obvious differences could be found in the data from the aged cat when compared with that of the young ones. Although the amplitude of accommodation of the aged cat was somewhat lower than the mean amplitude of the young cats, it was not significantly so. The equivalent human age of the animal was estimated to be 75 to 90 years. At this age man has long since lost all power of accommodation. A.

612.858

10151. Human skin perception of traveling waves similar to those on the cochlea. G. V. BÉKÉSY. *J. Acoust. Soc. Amer.*, **27,** *No.* 5, 830–42 (*Sept.*, 1955).

The membrane of a dimensional model of the mechanical parts of the human cochlea (30 cm in over-all length (showed under stroboscopic illumination travelling waves similar to those on the cochlea and a flat maximum of vibration which shifted from one end of the model to the other when the frequency was increased from 40 to 160 c/s. When the skin of the arm is placed in close contact with the membrane, the vibrations are localized in a quite narrow section of the membrane, so that any change in frequency can be detected by a change in the locus of stimulation. The localization is as sharply defined for pure tone pulses of the length of two sine waves as for continuous tones. The localization of pure tones along the membrane is practically instantaneous. The sharp localization in spite of the flat distribution of vibrations along the membrane is produced by the inhibitory

effects of the skin. Their influence and magnitude are demonstrated by various experiments. Some basic relations between nerve density on the cortex, threshold and loudness increase on the skin are pointed out in the hope that they will later enable us to determine the differences between the organ of Corti and the simple skin membrane. This would be helpful to our understanding of the nature and function of the complicated structure of the organ of Corti. On the whole, in the observation of pitch of pure tones, the simple skin-model is as useful as the organ of Corti itself. The differences become apparent only in the observation of more complex sounds. Two models were used to investigate the possibility of obtaining effects similar to the stereophonic effects in hearing.

A.

612.858.751

10152. Localization of sound from single and paired sources. T. T. SANDEL, D. C. TEAS, W. E. FEDDERSEN AND L. A. JEFFRESS. *J. Acoust. Soc. Amer.*, **27**, *No.* 5, 842–53 (*Sept.*, 1955).

Three experiments on the localization of airborne sound are described. They were conducted in an anechoic room and employed an acoustical "pointer" as the subject's method of indicating the direction of the stimulus tone. The pointer was a small loudspeaker carried on a boom which rotated about a vertical axis through the subject's head. This speaker presented a wide-band noise which alternated with the tone to be localized. The switching was transientless and was performed by an electronic gate having a 100-millisecond rise and decay time. Three small loudspeakers in enclosures, one mounted directly in front of the subject and one 40° to each side, presented the stimulus tones to be localized. In the first experiment the speakers were employed singly. In the other two experiments they were used in pairs. In the second experiment the pairs of speakers were in phase; in the third, they were in phase opposition. The stimulus conditions of Experiment 2 generate a "phantom source" which appears to lie between the two speakers employed. The predicted location is compared with the subjects' responses. The stimulus conditions of Experiment 3 generate a phantom source which according to prediction, should lie toward the side opposite to the asymmetrically placed speaker and should move in direction with frequency. This prediction is borne out by the subjects' responses for frequencies where interaural time is the dominant basis for localization. The results of the three experiments support the conclusion that the localization of tones below about 1 500 c/s is determined largely by interaural time differences. For frequencies above 1 500 c/s differences of intensity at the two ears must be the dominant factor, but neither probe microphone measurements nor audiograms for the subjects provided information from which satisfactory predictions could be made.

A.

612.858.76

10153. Patterns of injury produced by overstimulation of the ear. E. G. WEVER AND M. LAWRENCE. *J. Acoust. Soc. Amer.*, **27**, *No.* 5, 853–8 (*Sept.*, 1955).

Measurements of the cochlear potentials as recorded from the round window were carried out on a series of guinea pig ears to ascertain the effects of injury by overstimulation with various tones. The results showed general impairments of the responses after such injury. With rare exceptions, the maximum responses to any tone are much less impaired than the sensitivity, and the maximums are more seriously affected for the low tones. In general, these changes are independent of the frequency of the tone producing the injury. These observations confirm those of earlier studies on the patterns of action of tones in the cochlea, and indicate that all tones when raised to extreme levels cause widespread damage to the hair cells. It is suggested that certain hair cells, which are normally involved in the peak actions of all tones, are particularly susceptible to damage by overstimulation.

A.

TECHNIQUE. MATERIALS 62/69

681

10154. Angle-spring hinges. R. V. JONES. *J. sci. Instrum.*, **32**, *No.* 9, 336–8 (*Sept.*, 1955).

The hinges are based on the ease of twisting an L-section cantilever beam about its corner edge. The simplest form is easier to make, and is more compact, than a cross-strip hinge. The limitations of the angle-spring are described, and various designs of simply compensated hinges are indicated. Performance figures are given, showing that for angles of rotation up to 0·1 radian, the axis of a typical compensated hinge will remain constant within 10μ and within 10–15″ of arc. Such hinges can be useful components in instrument design, being free from friction and backlash.

A.

PHOTOGRAPHY 77

77

10155. New sensitive layers for scientific use. J. SIVADJIAN. *Royal Photographic Society International Conference* [*London*] 245–8. See Abstr. 7586 (1955).

The first material is sensitive to light and to water or humidity and allows numerous applications in physiology, meteorology, agriculture, analytical chemistry, etc. The second allows the detection of thermal effects, e.g. of ultrasonic waves. The paper describes the preparation, composition and properties of these materials.

A.

771.5

10156. New method of describing and measuring the granularity of photographic materials. R. C. JONES. *J. Opt. Soc. Amer.*, **45**, *No.* 10, 799–808 (*Oct.*, 1955).

The thesis of this paper is that the only fully adequate way to describe the granularity of photographic materials is by means of a film noise spectrum. The film noise spectrum bears the same relation to granularity as the power spectrum (of electrical circuit theory) bears to electrical noise. The film noise spectrum includes all of the information in the previous

granularity measures and readily interrelates them. It goes beyond the previous measures in that it leads to the solution of many of the signal-to-noise problems that arise in connection with the detection of target images on photographic materials. The film noise spectrum is defined and discussed, together with its relation to the older methods of description involving granularity coefficients, both ordinary and syzygetic. The superiority of the new method is explained in detail. The spectrum is used to derive the relation between ordinary granularity and syzygetic granularity. Photoelectric scanning of the film is discussed and general expressions derived for the signal and for the noise. These expressions are used to derive a particularly convenient method for the measurement of the film noise spectrum, and to solve the general problem of maximizing the signal-to-noise ratio in the detection of target images. The film noise spectrum of Super-XX film is considered. A.

771.534

10157. A sensitometer for serial determinations of the Schwarzschild effect (reciprocity-failure) over a wide range [of exposures]. J. EGGERT AND R. VON WARTBURG. *Z. Electrochem.*, **59**, *No.* 5, 355–63 (1955) In German.

Constructional and operational details are given of an automatic intensity-scale sensitometer using a step-wedge as intensity modulator; the exposure through the wedge being controlled by a solenoid-actuated falling shutter which also acts as an automatic switch for the lamp circuit. Two types of xenon lamp are used to cover the required range of short exposure times down to 10^{-5} sec, (1) a high-intensity flash-tube, (2) an arc discharge lamp. For longer exposure times, a tungsten filament projector lamp, with Davis–Gibson filter, is used at a colour temperature of 2 850°K. The instrument may be adjusted to accurately repeat a series of equal exposure-times within the range, 10^{3} to 10^{-5} sec. D. R. BARBER

771.534.5

10158. The measurement of high densities with photomultipliers. E. H. BELCHER, B. E. KEANE AND M. D. ROUSSEAU. *Royal Photographic Society International Conference* [*London*] 240–4. See Abstr. 7586 (1955).

The operating range of photoelectric densitometers may be considerably increased by the use of photomultiplier tubes. The design of instruments incorporating such devices is reviewed. Limitations imposed by photomultiplier dark current and fatigue are discussed, and the improvement in performance than can be achieved by refrigeration of the tube is assessed. Experimental data are presented of specular and diffuse densities measured on such instruments. A.

771.534.5

10159. A new reflection densitometer. H. NITKA AND D. W. STAMMERS. *Royal Photographic Society International Conference* [*London*] 233–40. See Abstr. 7586 (1955).

A photoelectric instrument suitable for routine black-and-white and colour densitometry of reflecting images is described. Sensitivity is adequate for the measurement of reflection colour densities up to 2·5 and black-and-white up to 4·0. An account is given of an investigation of the spatial distribution of light reflected from photographic papers differing widely in surface characteristics from which the choice of optimum angle of illumination and pick-up is made. Details of electrical and optical design are given. Some results in the rigorous evaluation of the performance of the instrument are indicated. A.

771.535 : 548.7

Photochemistry with X-rays in sensitized KBr crystals. *See Abstr.* 10075

771.535 : 548.736

Change in lattice dimensions of photographic emulsion grains irradiated with X-rays. *See Abstr.* 10090

778.37 : 535.34

High-speed photographic spectroscopy. *See Abstr.* 9558

778.5

10160. Electronic high-speed kinematograph and associated chronograph. P. DEVAUX, P. FAYOLLE AND P. NASLIN. *Royal Photographic Society International Conference* [*London*] 377–83. See Abstr. 7586 (1955).

The electronic-high-speed kinematograph camera described makes use of the Cranz–Schardin optical set-up for silhouette or schlieren pictures in conjunction with 30 krypton tubes and a 30-objective camera. The 30 circular images, 40 mm in diameter, have a definition of the order of 2 500 lines across the field and are taken with an effective time of exposure of 1 μsec. The electronic flash generator consists of 30 interchangeable discharge and delay circuits, the delays of which are individually adjustable between 1 and 20 μsec with an accuracy of $\pm 1\%$ or $\pm 0{\cdot}2$ μsec. When necessary, frame intervals may be measured with an accuracy of 0·01 μsec by means of a cathode-ray tube chronograph having a total capacity of 160 μsec. A motion picture film may be obtained by reprojecting the developed images on to the subject plane and photographing them frame by frame by means of a 16 mm motion picture camera. A.